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THE GLASS INDUSTRY.

By Prof. C. HANFORD HENDERSON.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XVII.

AT the beginning of the eighteenth century the glass industry was practically dead. The latter part of the century witnessed its slow revival. Some of these enterprises were short-lived; others outlasted the century. No very striking improvements were made, the most noted change being the substitution of coal for wood. But an immense amount of experience had been gained, and meanwhile a home market had grown up. The nineteenth century, therefore, opened with very flattering prospects. A united people had taken the place of a group of scattered colonies, while the improved standards of domestic comfort made greater demands upon the glass-maker's skill. The majority of people were no longer willing to make oiled paper do duty for glass in their windows, though even now, at the close of the century, there are thousands of cabins throughout the South which are destitute of a single window of any sort whatever. There was also an increased demand for glass table furniture and articles of luxury. The invalidism of an aging civilization created an unhappy market for patent medicines and other nostrums which must needs be put up in glass bottles. Greater delicacy in diet gave rise to the preservation of fruit and vegetables for the winter season, and made the production of jars for the purpose almost a separate industry. Both technical conditions and social requirements have thus conspired during the present century to forward the development of glass-making. Its history divides into two

periods, that preceding and that following the introduction of natural gas as fuel. The century opened with the almost universal use of wood, the new and experimental plant at Pittsburg alone making use of coal. It ends with an almost universal use of natural gas, where it can be obtained, and an unmistakable tendency to substitute manufactured gas for coal where Nature has not supplied the gaseous fuel.

The States which now lead the glass industry, Pennsylvania and New Jersey, were already at the front in the beginning of the century. In Pennsylvania there were a number of enterprises on foot. Philadelphia took quite an active part in this development. The Kensington works, established by Robert Towars and Joseph Leacock in the fall of 1771, had passed through a number of hands, but was fairly continuous in its operations. It ultimately came into the possession of the Rowland family, and was sold by them in 1833 to Dr. Thomas W. Dyott, a notable figure in the annals of our early glass-making. They were at this time the most extensive glass works in the country, melting about 8,000 pounds of batch every day and turning out something like 1,200 tons of glass a year. This was chiefly in the form of bottles and druggists' supplies. There were five furnaces adapted for burning both coal and wood, as well as North Carolina rosin. From two hundred and fifty to three hundred hands were employed in carrying out the various operations. Dr. Dyott failed in 1838, and the works were idle for several years, thus losing their former prestige. There were also window-glass works at the Falls of the Schuylkill, and another lower down on the river at South Street wharf. When the first census of manufactures was taken, in 1810, there were two glass works in the county and one within the city limits, the joint product of which amounted to only $26,000. Glass-making does not seem at that time to have been very successful in Philadelphia, for in 1820 there was but one plant reported in the whole county. In that year a co-operative flint-glass works was started in Kensington, but it did not succeed. In 1840 there was but one works reported.

Here as elsewhere throughout eastern Pennsylvania there has been, since then, a steady increase in productive power, but relatively there has been a marked decrease in the industry. The character of the product, too, has changed. Philadelphia probably produces at the present time about two million dollars' worth of glass a year. None of this, we believe, is sheet or window glass, except a little for decorative windows. The most of it consists of the fancier sorts of hollow ware, lamps, globes, chimneys, cut glass, and other forms of domestic glassware and of articles of luxury. The reason of this change is quite obvious. In the production of glass in the mass, such as window glass and plate glass, Philadel-

phia and the eastern part of the State could not possibly compete with the Pittsburg district. The conditions are much less favorable in the matter of fuel and crude materials. Skilled labor, however, is more available, and artistic influences are more in the air. In the production of this finer ware the intellectual element is so much the larger ingredient that the cost of the bare material itself is of less moment. In consequence we find Philadelphia at the present time an important center in what may be called the æsthetic department of glass-making. We find here the manufacture of large quantities of decorated gas globes, together with such other wares as require the etching action of hydrofluoric acid, and of cut and engraved articles of various designs and for multiform uses. It was here that the process of making cameo glass was imported from England. This department of glass-making, it is true, has not proved commercially successful, but the manufacture of the cameo ware well illustrates the tendency toward variety of product which is shown by industrial centers depending for success upon nicety of workmanship rather than quantity of output.

These conditions have also given rise to the invention of machines and processes noted for their ingenuity and importance. The sand blast, by which glass is quickly and cheaply ground by exposure to a blast of air charged with sharp sand, is the invention of a Philadelphia gentleman, General B. F. Tilghman. So powerful is the abrading action that a plate of corundum may be drilled in this manner, and even the diamond is worn away. The blast has also been applied to the manufacture of files, and to the drilling of metal plates.

The industry also started up in a number of other districts in the eastern part of the State. The attempt made by Mr. George Lewis, an English gentleman, to establish glass works at Eaglesmere some time between 1803 and 1809 was scarcely less picturesque than the earlier efforts of Baron Steigel. In 1886 the ruins of the glass-house were still to be seen on an eminence overlooking the lake. An old frequenter of the place—for it has since become a well-known summer resort—was fortunate enough to have in his possession some excellent specimens of the early glass. But in the first decade of the century it must have been a lonely place, and we can not help wondering that any one should have had the temerity to put a glass-house there. It is true that the natural conditions were good. The sand at one end of the lake is beautifully white and pure, while the surrounding forests furnished an abundance of fuel and alkali. The glass-making seems to have been a technical success, and it is said that Mr. Lewis made considerable money during the War of 1812, but the difficulties of transportation were ultimately too

much for the enterprise. The works were separated from the markets by long distances, and by roads which, after the lapse of nearly a century, are still very rough. Mr. Lewis appears never to have lost faith in the undertaking, but after his death the works were finally abandoned.

There are doubtless many other quiet localities scattered throughout the State which could tell a similar story of endeavor and perseverance and failure. West of the mountains the development of the glass industry has been phenomenal. The works established by Mr. Gallatin at New Geneva in 1797 continued to make window glass for many years. They were, however, finally abandoned toward the middle of the century. But the establishments at Pittsburg became the nucleus of a glass-making center which is to-day quite unrivaled in importance by any other glass center in the world. In the early days it was not all smooth sailing by any means. But the men who nourished the industry seem to have possessed unusual enterprise and perseverance. Their pioneer efforts in the use of coal in place of wood was in itself an act of no little industrial courage, for even in 1810 this remained the only plant in America which used coal. The product of the Craig and O'Hara factory was chiefly window glass, though an occasional lot of bottles was also turned out. About 1800 a second glass-house was established in Pittsburg by Denny and Beelen. It used wood exclusively as a fuel—being so situated, indeed, on the north side of the Ohio River that coal was not readily obtainable. The works did not prove successful and were soon abandoned.

The records of the industry show the establishment of various other works during the early part of the century, but the majority of them were unsuccessful and were sooner or later forced to suspend. The first flint-glass works were probably those established by Messrs. Bakewell and Page in 1808. They started with one six-pot furnace, but met with such flattering success that they constantly enlarged the capacity of their works. In the census of 1810 it is stated that "decanters, tumblers, and every other description of flint glass of a superior quality" were manufactured at Pittsburg. From this time onward the growth of the industry has been continuous and rapid, except during a brief period preceding 1819, when a temporary decline was experienced.

It would be both uninteresting and foreign to the present purpose to enumerate the separate histories of these various enterprises, but the figures illustrating the growth of the industry from this time on to the tenth census are too significant to be passed over in silence. Thus in 1837 there were thirteen factories in Pittsburg, yielding an annual product of about $700,000. In 1857 there were twenty-five factories, with a yearly output valued at

$2,600,000. It will be noticed that while the number of establishments only doubled during this interval of twenty years, the value of the product was nearly quadrupled. At the time of the tenth census—that is, in 1880—there were fifty-one factories, yielding an annual output of about $6,000,000. The importance of Pittsburg as a glass center can best be appreciated by considering these figures relatively to the whole American output. The one district of Allegheny County produced a little over a quarter of the entire glass manufactured in this country, while the State, as a whole, made a trifle over two fifths of the total. The product was window glass, hollow ware, and green glass, no plate glass appearing in the State returns up to that time.

While the other conditions were also favorable, the chief cause of this marked development in Pennsylvania has undoubtedly been her fuel. During the first ten years of the century her forests alone were used to any extent, but the substitution of coal for wood went on continuously for the succeeding seventy years, until in 1880 it was everywhere the chief fuel, wood being employed only in heating the annealing ovens and for other minor purposes. Up to 1880, however, the development of the industry consisted for the most part in the improvement of already existing devices. The furnaces were made larger, the chemicals were purer, the melting pots more capacious. The coal was burned to better advantage, and consequently the batch was more thoroughly fused. Greater differentiation of the processes was being slowly brought about. In window-glass factories separate furnaces were provided for melting and blowing. In the handling of the glass there were similar improvements. The continuous rod leer was coming into use, while bottles and other hollow ware were annealed in iron trucks and no longer needed separate handling. All these were substantial gains; yet up to 1880 the fact remained that no very radical changes had been introduced into general glass-making practices—we do not here refer to the subsequent working of the material—and it was undeniable that the American product was in many respects inferior to the imported. We could not at that time successfully compete with Belgium even in the matter of window glass.

But during the past decade there has come a change so radical and so far-reaching in its results that more glass history has been condensed into these busy ten years than is to be found in the previous eighty years. The natural-gas well has been a veritable Aladdin's lamp to the glass industry. The fuel itself has been known for many years. As early as 1775 Washington had a "burning spring" on the tract of land deeded to him in the Kanawha Valley for military service, which he desired to make public property; but through some technicality the grant

was never completed. The first utilization of natural gas of which we have record was at Fredonia, in New York, in 1821. This first well was an inch and a half in diameter and only twenty-seven feet deep. The gas was used solely for illumination, and when Lafayette visited the town, in 1824, the inn where he stopped was thus lighted. The Fredonia well excited an immense interest on both sides of the Atlantic, and so great a man as Humboldt is said to have declared it the eighth wonder of the world. Yet there seems to have been little effort to duplicate the wonder. Even at Fredonia a second well was not sunk until 1850. The first use of the gas for manufacturing purposes was probably in 1841, when William Tompkins burned it to evaporate brine in the Kanawha Valley. From this time onward the natural gas came slowly to be used under boilers to drill salt and petroleum wells, and occasionally to heat and light the houses in neighboring villages, but on the whole the gas was regarded as a danger and a nuisance. It was not until April, 1873, that gas was used in iron-making. In the fall of 1875 it was introduced into a large rolling mill near Pittsburg.

About this time the new fuel was also introduced into glass-houses. It is believed that the Rochester Tumbler Company, at Rochester, Pa., was the first to utilize the gas in the processes of glass-making. At the present day it seems odd that so eminently convenient and economical a fuel should have been so slow in coming into use. The Government reports on the Mineral Resources of the United States make no mention of natural gas until 1883 and 1884. In the volume for those years it appears for the first time as an economic product of sufficient importance to be noticed. Eight years have passed, and now the capital invested in natural gas is probably not far from one hundred million dollars. In the latter part of 1883 the gas began to be introduced into Pittsburg glass-houses. Mr. John B. Ford took an active interest in this development. During this and the following year he exploited the now celebrated Tarentum district in order to obtain a supply of gas for the plate-glass works which he had just built at Creighton.

The transition from solid to gaseous fuel took place with astonishing rapidity. By 1885 all the glass-houses in Pittsburg and the neighborhood which could obtain gas cheaply were using it for all purposes of melting, blowing, manufacturing, and annealing. It was possible to make the substitution so suddenly both because of the rapid exploitation and development of the gas territory, and because of the comparatively small changes needed to adapt coal-burning furnaces to the gas. Where the gas was burned for power, under boilers, the old grates were in many places retained and the gas-burners so arranged that, in case of

any interruption to the flow, a coal fire could be started in six or eight minutes. In the glass furnaces themselves greater changes were necessarily made. As the supply of gas became more abundant and assured, the tendency was toward the evolution of distinct apparatus for its utilization. At the present time the glass furnaces burning natural gas are models of simplicity and efficiency. In the melting furnaces the gas is admitted at each end of the furnace and mixes with air which has previously been heated by passing through flues in the brickwork. The combustion thus takes place in the melting chamber directly above the crucible pots, and produces an intense and easily regulated heat. The blowing furnaces are even simpler. They merely provide a chamber of brickwork with suitable openings in the sides, and immediately under each opening a large Bunsen burner supplied with natural gas and drawing the requisite air directly from the atmosphere.

Under the stimulus of the new fuel the development of the glass industry since 1885 has been without precedent. The greatest growth took place first in the flint-glass works, because in these the advantages of the gas were most manifest. The absence of coal smoke and dust, and the tendency to reduce the lead oxide to the metallic state, were in themselves sufficient to bring about the substitution of the gas for the coal, had there been no other reasons. But the economic advantage was also in favor of gas. Thus, a factory which was run by coal in 1883 at a weekly cost of $175.17 was operated by natural gas in 1885 for $94.96, effecting a saving of forty-six per cent. In addition to this the repairs were less costly and the product was more salable.

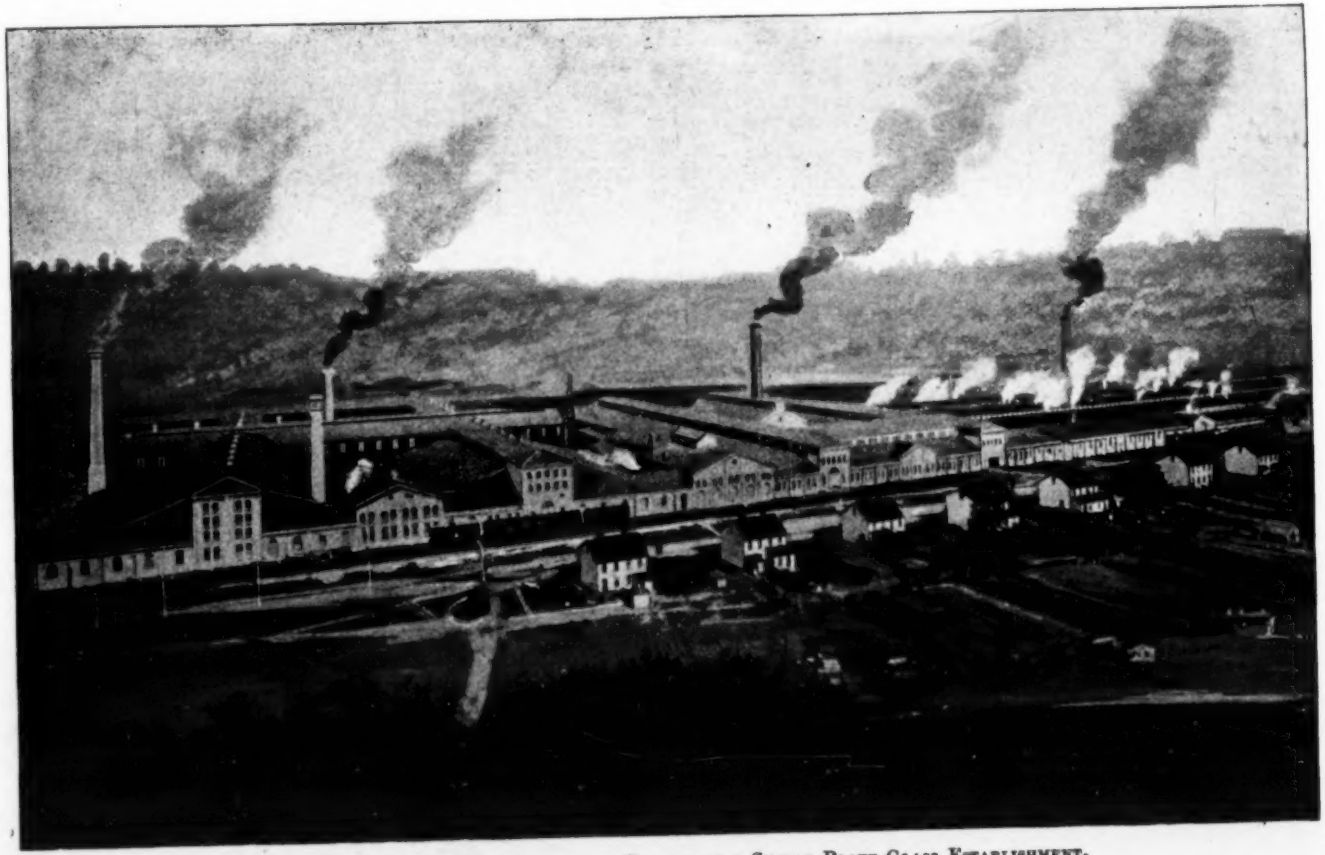
The introduction of natural gas into window-glass factories was held for some reason to be less advantageous than in flint-glass works, but the tradition rapidly melted away in the face of a larger experience. By 1885 and 1886 natural gas had made its way into all departments of glass-making, and everywhere turned out to be an immense improvement. Now it is the universal fuel, and up to the present year it has been the cause of that concentration of the industry of which we have already spoken. It has not only given a better product and more economic working, but it has made possible the carrying out of operations on a scale hitherto undreamed of. In plate glass and window glass the product is now measured by the acre, and even by the square mile, where formerly it was reckoned in feet. Hollow ware is shipped by the ton in place of pound lots. One hundred and twenty thousand dozen lantern globes are turned out as a summer's work. With the more complete organization of the industry it is no longer necessary for large plants to grow out of small ones. The conditions need-

ful for success are now pretty well known, and where these are found the most extensive works may spring up without any previous history. So we find in the enumeration of an establishment, now in course of construction, one item of one hundred and twenty-five two-story houses, while the plant itself is to be one of the most perfect and extensive in this country. These sudden growths will become more and more possible with the progress of industrial analysis.

In the neighboring State of Ohio the industry gained small footing until within recent years. There were two glass-houses in operation in 1817, and others were subsequently started, but they do not appear to have succeeded, for none were reported in the census returns of 1840. Ten years later there were six in operation, but in 1860 the number had decreased to four. In 1870 the total establishments numbered nine, and at the time of the tenth census had increased to a score. With the discovery of natural gas, however, the industry experienced a sudden expansion, and the State is now one of our most active glass-producing centers. Gas was known as early as 1836, but it was not until 1884 that it was regularly sought for and utilized. In the fall of that year a successful well was drilled in the now famous Findlay district. This was followed by other wells in 1885, and in 1886 by the Karg well, one of the most prolific in the entire country. A few months later the Van Buren well yielded even larger returns, and firmly established the reputation of western Ohio as assured gas-producing territory. Bowling Green, twenty-four miles to the north of Findlay, became a second important gas center. Both towns are underlaid by Trenton limestone, and draw their supplies of gas from the same geological horizon. Other gas rock has been discovered, but this remains by far the most productive.

The history of these and other districts in the gas country reads quite like an industrial fairy story. Quiet country towns have expanded in a surprisingly short space of time into manufacturing centers of national importance. In this development glass-making has been the foremost industry. By 1888 there were a dozen different establishments at Findlay alone, making bottles, window glass, and flint ware of fine quality, while the population had increased from six thousand to thirty in about eighteen months. At the same time Bowling Green had five glass-houses, and Fostoria five more. Numerous other establishments are found scattered over the entire State.

The development of glass-making in Ohio, in addition to the mushroom rapidity with which the industry has sprung up, presents a number of unique and interesting economic features. It has been practically a race between the different localities as to which should secure the greatest number of establishments



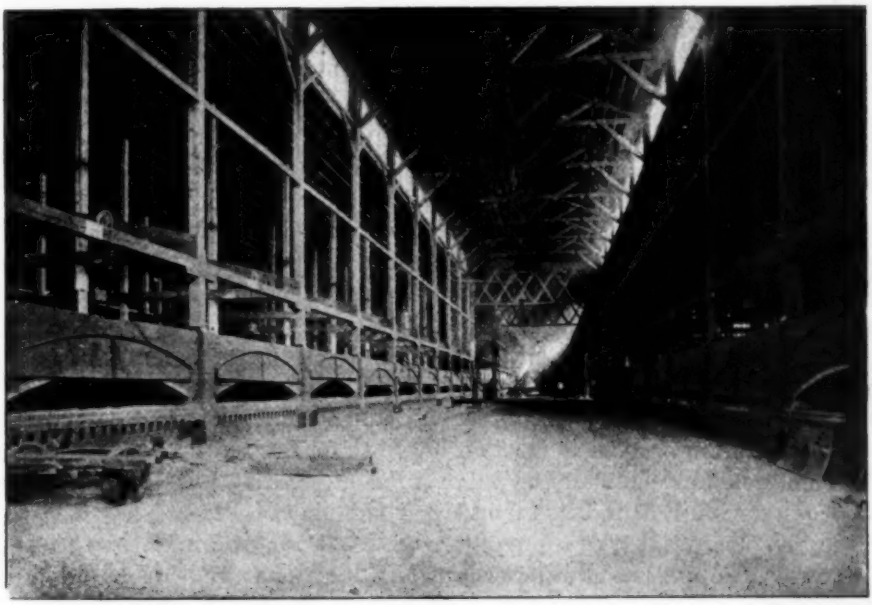
VIEW OF FORD CITY, PA., SHOWING THE EXTENT OF A SINGLE PLATE-GLASS ESTABLISHMENT.

and build up the largest communities in the shortest time. The means employed were eminently socialistic. The business of town "booming" was intrusted to the town corporation itself, instead of being left to private effort. The town undertook the work of exploration, drilling the wells, and finally of supplying free gas to all manufacturing concerns which would settle within the town limits. Tiffin has been particularly active in these corporate ventures. In about one year it spent two hundred thousand dollars in the work of development, and, besides the pledge of free gas, furnished fifty thousand dollars to secure a large glass factory. It was a somewhat daring policy, but it succeeded so well that other towns soon followed its example. Where they had no money to give, they gave free gas and ten-acre lots. Thus solicited, the glass industry became a willing immigrant and invaded the State in generous proportions. This phase forms indeed a curious chapter in our industrial history, and is a strong contrast to the mortal struggles of our earlier glass-makers.

The industry had a very similar history in Indiana, though on a less extended scale and at a somewhat later period. The State was early identified with the plate-glass manufacture, but it was not until the development of natural gas that it took a prominent place. The whole southeastern part of Indiana is underlaid by the Trenton limestone, and is a highly productive gas territory. Its history begins with the drilling of the Kokomo well in the fall of 1886. This gave a daily output of two million cubic feet, and was soon followed by others yielding six and seven million feet. Throughout the entire State the work of exploration proceeded with astonishing rapidity. Few districts, indeed, have been so thoroughly exploited. It is now one of the three chief gas-producing areas in the United States, and has attracted a proportionate number of glass factories.

Certain branches of the industry, such as the manufacture of plate glass, can hardly be said to belong to any State, for it has shown itself decidedly peripatetic. The first attempts were probably those made at Cheshire, Mass., in 1852–'5. After an unprofitable run of six months, the works were removed to Brooklyn, N. Y. Here there was more experimenting and more loss. The enterprise was abandoned in 1856. This same year a second attempt was made at Lenox, Mass. After some initial difficulties and failures the works got successfully under way and continued to manufacture rough plate until the close of the war. A new company was then formed and undertook the production of polished plate. A machine which had been invented to grind and polish marble was found to do equally good work on glass, and was put into operation with excellent results. In a modified form it is still employed, both in this country and in Europe. The com-

pany prospered for some time, but through unwise management finally failed. But the American plate-glass industry, though apparently doomed to suffer severe reverses, was not doomed to die. In 1869, two years before the Lenox failure, a carefully designed plant was put into operation at New Albany, Ind., by Mr. John B. Ford. He imported the first grinding and polishing machinery from England. Although these works have been operated continuously ever since then, and are now reasonably successful, they had to run the gantlet of early reverses. Their owner, Mr. W. C. De Pauw, stated before the tariff commission that up to 1879 no money was made at his own works, and that he believed other



Interior View of the Casting Hall at Ford City, Pa.

manufacturers of plate glass in America had had a similar experience. The industry up to that year seems indeed to have been one succession of financial disasters. Yet these failures do not appear to have discouraged their promoters. Between 1870 and 1875 Mr. Ford established other works at Jeffersonville, Ind., and at Louisville, Ky. About the same time a large plant was also built at St. Louis, and, like the others, was equipped with English machinery. It was at that time the largest factory in the United States. The industry was slow in establishing itself at Pittsburg, but it has since reached its greatest development in that district. The Pittsburg Plate Glass Company began operations in 1883, their first factory being at Creighton. The monthly output was about

40,000 square feet, or nearly an acre of plate glass. The demand for the glass increased so rapidly that two years later, in 1885, a second plant was built at Tarentum. Meanwhile the methods of manufacture at Creighton had been so far improved that the joint output of the two factories was 280,000 feet per month, or between six and seven acres of polished plate. In another two years the same company built a third factory at Ford City, with a capacity of 200,000 feet per month. At the present time these works are being still further enlarged, and will soon have more than twice their original capacity. The growth of the enterprise has been remarkable. It is doubtful whether any other industry could show a parallel development. At the present time the annual output is in the neighborhood of a third of a square mile of polished plate. That means a great deal of sunshine for somebody.

These American plate-glass works compare very favorably in equipment and management with the more historic establishments of Saint Gobain and Ravenshead. The native product, we believe, is now quite equal to the foreign, and promises sooner or later to so far discourage importation as to be itself exported. It is pleasant, too, to record that, after so many disasters, this branch of glass-making is at the present moment the most flourishing of all departments of the industry. It is the one in which the American genius for mechanics has had the greatest scope. Few of the operations are performed by hand. These are precisely the conditions under which America can compete most successfully with the Old World, and feel the least disadvantage from her more expensive labor market. This thoroughness of organization has had its effect upon the price. Plate glass is today so cheap that, as some one has said, it may be used in farmhouses, though it should perhaps be added that in this case the farm itself must in times past have been rather profitable. It is, at any rate, no longer exclusively the window glass of the rich. This widening of the market has made possible the present success of the industry. When the price becomes so low that we can afford to use twice as many acres of plate glass as we now allow ourselves we may expect a still greater success. At the present time the tendency is decidedly toward largely increased production. There are now eight plants in full operation, and four more in course of construction, which will probably be under way during the early part of the year. The market is large enough for all, though there is naturally a considerable rivalry between the different factories. This shows itself, among other ways, in the effort to outdo one another in the size of the plate produced. The largest yet turned out is one, we believe, made by the Diamond Glass Company at Kokomo, Ind., which measures 153 by 212

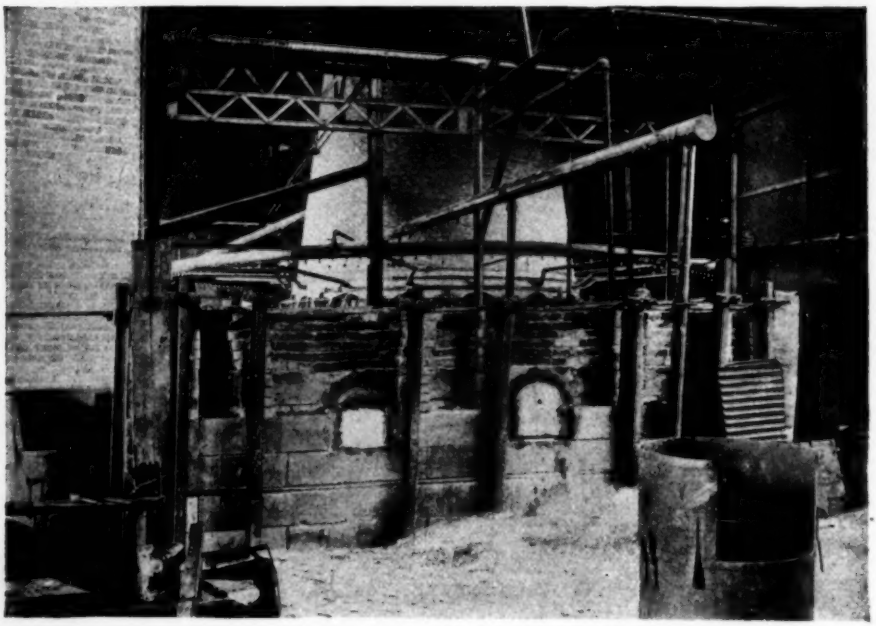
inches. It is almost needless to say that the sole fuel used in all these works is natural gas. It has, indeed, made possible their large extension and success. At Ford City alone contracts were recently given for the drilling of seven wells at the same time.

In the second producer of glass in the United States, New Jersey, there has also been a continuity of operation not met with elsewhere. The early factories of Salem County and at Glassboro were the nucleus of a large and thriving glass settlement. The very favorable natural conditions early made the State the center of the bottle trade. Many of the works established during the first half of the century went out of existence after a few years'

Interior View of the Grinding Hall at Ford City, Pa.

more or less successful run. But others, such as the works established at Millville in 1822, continue among the most important in the State. The introduction of anthracite as a fuel does not seem to have been made until 1856, though even at the present time wood is largely used in the annealing ovens. The weakest element in the New Jersey glass industry lies right here, in her deficient fuel. With various town corporations in Ohio and elsewhere offering natural gas free to glass-producers, the competition is very unequal, for the manufacture of bottles requires no great purity in the sand and no very special skill in the blower. Yet this rivalry appears to have been successfully met, for there has been during recent years a marked increase in the output of

the Jersey glass-houses. New plants have been established in various places, and the capacity of old ones enlarged. At Glassboro, for instance, one of the oldest glass-houses in the country, the output was recently doubled within a period of three years, and has since gone on steadily increasing. The history of these works is indeed typical. The original glass-house was built in 1775 by the Stanger brothers, seven in number, who were all practical glass-blowers. They continued operations with reasonable success until the close of the Revolution, when the works were sold to Colonel Heston, the great-grandfather of the president of the company now operating the works. It is of interest



TANK FURNACE USED IN THE MANUFACTURE OF LAMP CHIMNEYS AT JEANNETTE, PA.

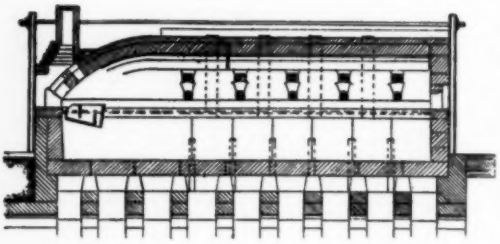
that four generations have been connected with the one enterprise, a somewhat unusual persistency in the history of American industry. In 1887 the enterprise was incorporated as the Whitney Glass Works, and in the following year purchased the works at Camden. These, with the works at Glassboro and Salem, give the company an immense productive power and make their undertaking the most important glass industry in the State and one of the most important in the whole country. This increase of capacity is largely, if not entirely, due to the introduction of improved tank furnaces, the invention of the chemist of the Glassboro Works, Mr. Andrew Ferrari. These are modifications of the Siemens regenerative furnace, but differ from it in having the gas

generator directly alongside of the melting chamber instead of at a distance. The coal is burned on the ordinary step-grate to carbon-monoxide gas which passes while still hot directly to the combustion area. At the bridge separating the generator from the melting chamber the gas mixes with the requisite amount of heated air, and, being itself hot, produces by its combustion a sufficiently intense heat to accomplish the perfect fusion of the batch. This proximity of the generator to the melting chamber obviates the great difficulty which had hitherto interfered with the use of gas as a fuel in glass-making—that is, the difficulty in obtaining a sufficiently high temperature. There are five of these tank furnaces at Glassboro, two at Salem, and one at Camden. This improvement is directly in line with local needs, since it has effected a saving of over fifty per cent in the cost of fuel. The expression is somewhat hackneyed, and unavoidably brings to mind the individual who was so delighted with a stove which saved fifty per cent that he proposed to buy two and so save a hundred per cent; but the reported saving in the case of the furnaces is the result of several years' experience and is quite authentic. Nor is this the only saving effected by the tank furnaces. They do away with the large expense of crucible pots and reduce the cost of repairs to a purely nominal sum.

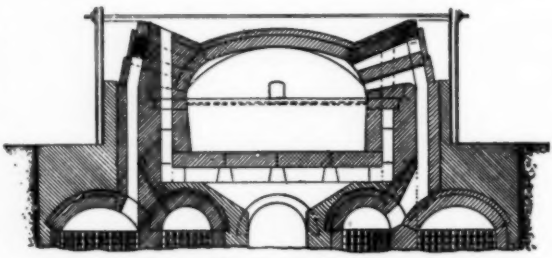
No invention could have been more timely. In the face of the serious competition at Pittsburg, the New Jersey bottle industry, with its expensive fuel, would have fared but ill had it continued to melt its sand and lime and alkali in the old-time pot furnace. The tank furnace has served the industry in good stead. Within the past few months another important improvement has been introduced at Glassboro, in the substitution of crude petroleum for coal as fuel. Formerly its use was limited to the "glory-holes," where the mouths of the bottles were finished in an aureole of yellow flame. Now it serves also for melting the glass and annealing the ware. A large storage tank has been constructed, and it is believed that in a short time oil will entirely supersede the use of coal. A fourth chapter in the history of glass-making may soon have to be written in which petroleum figures as the dominant element. The Glassboro people, at least, are disposed to look upon its introduction as somewhat epoch-making.

At the present time the eyes of the bottle-making world are also turned toward New Jersey for another reason. Their glance centers upon Woodbury, for in that quiet village the destiny of the bottle-blower may be said to be on trial. The Ashley bottle-making machine has been set in operation to see if it can not do the work of human hands and lungs, and do it better and more economically. The machine was described before the British Association in 1889, when it was stated that bottles had been made by the

machine, quite complete, which had successfully been subjected to an internal pressure of three hundred pounds to the square inch. The career of the machine in England, we believe, has been most unfortunate, but this does not at all diminish the interest which its introduction into America has excited. The advantages to be gained by the use of such a machine are much too solid to permit small obstacles to hinder its success. The trial run at Woodbury has been fairly successful. The automatic principle has not been developed to the full extent in these machines, but it has been carried so far that one man and three boys—none of them necessarily skilled glass-blowers—can operate two machines, each of which is capable of turning out two bottles a minute. The machine does not gather the glass. One of the boys, the "gatherer," is specially detailed for that service. He feeds the molten "metal" to the machine, in which it is mechanically molded, the neck and mouth formed, the interior blown by means of compressed air, and the finished bottle automatically delivered to a carrier which takes it to the annealing oven. There is undoubted room for improvement both in the performance and capacity of the machines. But the important step has been taken, and bottles have really been made in this country by machinery. One need not be very sanguine to believe that the initial step will lead to others, and that in the future not only bottles, but all other forms of blown ware, will be made mechanically. This is indeed only in the line of industrial development which is everywhere substituting continuous automatic processes for those which are discontinuous and organic. An experienced glass manufacturer, who has been for many years identified with the development of the industry in New Jersey, thus sums up present realities and tendencies: "The use of petroleum, the introduction of the tank furnace, and the bottle-making machine are the three great and only improvements that have been



SIEMENS TANK FURNACE. Longitudinal section.

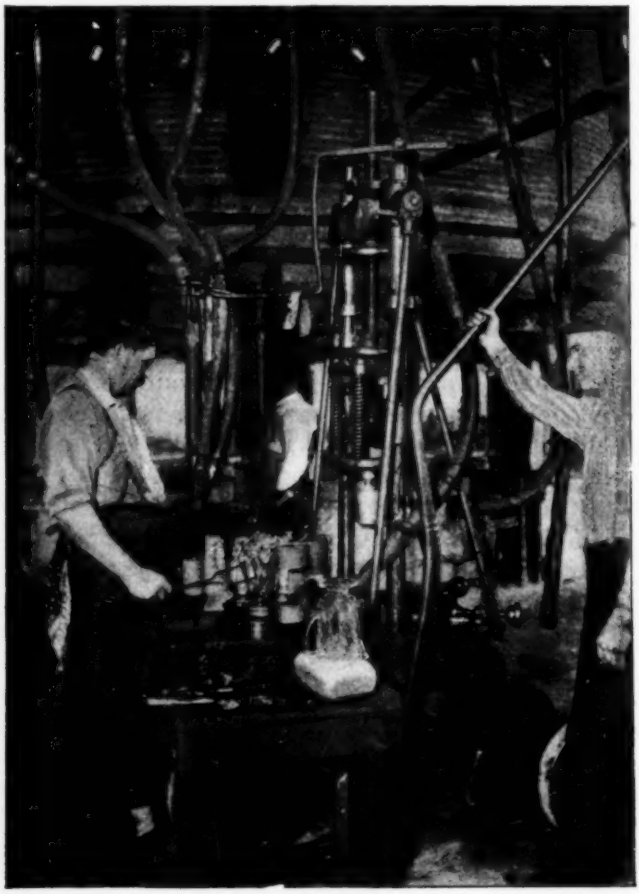


SIEMENS TANK FURNACE. Transverse section.

made in glass-making for a long period of time. The tank furnace is rapidly superseding the old-fashioned pot furnaces, and in a very few years I do not think a pot furnace will be in operation in the entire country. The manufacture of bottles by machinery is comparatively new here, and, although it has been attempted a number of times, it has never been a pronounced success until recently. It is still in its infancy, but next year I think will see a large portion of the commoner kinds of bottles made in this way. I have no doubt that ultimately all articles of blown glassware will be made by machinery."

Although the attempt to establish glass-making in New England never met with great or permanent success, it is to Yankee inventive skill that we owe much of the means of success elsewhere. In these attempts Massachusetts took the lead in the nineteenth century, as she had in earlier days. In addition to the Boston works, established in 1792, a successful window-glass factory was started at Middlesex village in 1802. This gave employment to one hundred persons in all and turned out annually about eight acres of glass. It continued in operation a full quarter of a century, when it was shut down on account of the failure of the proprietors. The works were burned, but were soon after rebuilt, and in 1829 a company undertook to manage an industry which had failed in individual hands. They continued to make glass there for about ten years, when they removed to New Hampshire, attracted probably by greater abundance of fuel. Works were also established at Cheshire in 1812, and others in 1853 at Lenox. The latter was devoted to the production of window glass, and proved the most successful and enduring of the number. Several flint-glass houses were started in and around Boston, and were very successful during the early part of the century. The works at East Cambridge, built about 1812, have been particularly productive. Six years after they were started they are reported to have been "one of the most extensive flint-glass manufactories in the country." They had at that time two furnaces and twenty-four cutting wheels. The plant also included a furnace capable of turning out two tons of red lead a week, and was in other ways well equipped for the production of the finer wares. In 1823 22,400 pounds of glassware represented the weekly product. In 1865 the number of furnaces had been increased to five, the number of people employed being five hundred, and the value of the yearly product not far from $500,000. This, however, represented high-water mark, and was soon followed by a considerable decrease in activity. More significant was the flint-glass house established at Sandwich in 1825, for it has the reputation of having made the most important of American contributions to the technique of glass-working, and that is the glass-press used in the

production of pressed glassware. The works started in a modest way with one eight-pot furnace, and increased their capacity as circumstances warranted. About two years after the works were built a local carpenter applied to the proprietor for a bit of glassware needed in some building operation, and was told that it could not be supplied. He suggested that the material might be pressed



A Modern Glass-Press.

into the shape he wanted. With the co-operation of the proprietor a rough press was made, and after some experimenting was found to answer the purpose admirably. A glass tumbler, stated to have been the first one made, was exhibited at the Centennial Exposition in 1876, but was unfortunately broken. From this incidental suggestion, given, too, by an outsider, the present extensive industry takes its rise. The American press is now used in nearly all the glass-producing countries of Europe, and has

made possible our own plentiful output of beautiful and inexpensive tableware, as well as of artistic panels used in transoms and elsewhere. The pressed glass is not, of course, so brilliant as the cut, but it has the merit of costing less than one twentieth as much, and therefore of being within the reach of all. Later, the glass works were operated by the Boston and Sandwich Glass Company, and enjoyed quite a boom during the civil war. The stock commanded a ready market and became one of the conservative investments in which careful Bostonians took pleasure in putting their money. Since then operations have not been continuous, but the enterprise is still represented. After the war the glass industry in Massachusetts dwindled sadly until, in 1880, there were only five flint-glass houses and one window-glass factory in operation in the entire State. The cause of this decline was largely due to lack of fuel, and also in part to the pressure of other industries for which the locality is better adapted.

Massachusetts must, however, always hold a prominent place in the annals of American glass-making, both because of her service in developing the plate-glass manufacture and the possibilities of pressed glass, and still more because she has now within her borders the most noted of American workshops for glass. The lens-grinding establishment of Alvan Clark and Sons, at Cambridgeport, is known wherever the science of astronomy is cultivated. Its achievements in producing the glass for the Russian Imperial Observatory at Pulkowa and the giant lens for the Lick Observatory in California are still in mind. The contributions of the State must, therefore, be measured by intellectual standards rather than by avoirdupois or dollars and cents.

In other parts of New England the development of the industry has been exceedingly moderate. New Hampshire seems to have been an asylum for the disgruntled glass-makers of Massachusetts. Since the times when Robert Hewes betook himself to Temple and the Middlesex workers removed to Pembroke, the forests of the State have been fatal allurements to those across the line. Few, if any, of these northern migrations proved successful. The works established at Keene, in 1814, for the manufacture of window glass continued in operation until the middle of the century, but appear to have been a losing venture in the hands of the several parties who attempted to run them. The bottle factory established in the same town, in 1817, was somewhat more prosperous, but in 1848 succumbed to the same enemy which attends all such industries, a lack of sufficient fuel. At the time of the tenth census the bottle-house at South Lyndeborough was the only glass factory in the State.

The development of the industry in the other New England States has been correspondingly meager. In recent times there

has been a slight revival of activity, but it is of little moment compared with the greater work being accomplished farther west.

The records of glass-making in New York and Maryland are somewhat fragmentary. In both States there have been a number of more or less promising enterprises whose histories are not dissimilar to those of corresponding glass works in Pennsylvania and New England. In Maryland, at the present time, the activity in these lines is chiefly centered about Baltimore and Cumberland, the product being for the most part window glass and hollow ware. The development of the industry in New York has been more varied. In objects of strict utility the output of the western part of the State is now quite large, but the most distinctive products are in the line of artistic workmanship. The cut glass produced in the *ateliers* of New York State is equal and probably superior to that of any other section. It compares indeed very favorably with the imported product. But the most praiseworthy product of the State, and indeed of the entire country, if we except the lenses of Cambridgeport, is found in the magnificent picture windows made in New York city from glass especially cast for the purpose in Brooklyn. In these translucent mosaics we have the very crown of American workmanship in glass. The most admirable of these mosaics, such as the memorial windows done by Mr. Tiffany, are works of art of the highest order. In addition to their wealth of luminous color and form they present something which, unfortunately, all reputed works of art do not, and that is, a clearly discernible idea. Compared with the intellectual pleasure which these windows afford, the beauties of other forms of glass work, however brilliant they may be, must appear somewhat unsatisfying.

A Modern Picture Window. Copyrighted by the Tiffany Company.

If we ventured in this sectional summary of the industry to pass judgment upon the work being done, we should be obliged to accord the first rank to New England in the matter of intelligence; to New York, for artistic merit; and to the belt of country

stretching westward from New Jersey and Pennsylvania, for the eminently utilitarian quality of its products.

But the most important thing in regard to the development of glass-making in America remains yet to be said. It is the tendency which the industry discloses in this year of grace 1893, four centuries after the discovery of the country. The events briefly outlined in the foregoing pages have given the industry a certain heredity, if one may so express it, a certain projectile force which tends to carry it along easily distinguishable lines of development. Acting with this in point of time, and occasionally against it in the matter of direction, there is an equally definite industrial environment in the midst of which this force is to operate. One is made aware of these dual factors by a comparative study of the census reports. But industrial history is made so rapidly at the present time that, if one is to speak of the tendency of to-day, it must be in the light of strictly contemporary events. The importance of the glass industry has warranted the establishment and maintenance of a number of very admirable trade journals, and it is in the columns of these journals that one is able to discern the signs of the times.

There is an unmistakable tendency toward the substitution of machine for hand processes. It suits the American temper better to exercise itself over the invention of a machine, or over the improvement of one already invented, than it does to plod along in the exercise of a routine dexterity. So we find the most rapid growth and the greatest relative perfection in those departments the most dependent upon mechanical processes, such as the manufacture of the pressed ware, of bottles, and of plate glass. Not less marked is the tendency to supplant the reservoir system of melting in pots by the continuous system represented by tank furnaces. In one department, that of bottle-making, this substitution, as we have already seen, has been in large measure carried out, and in other departments it seems indeed only a question of time as to when it will be realized. Similarly in the matter of fuel, the continuous supply of gas is rapidly taking the place of the less convenient and less continuous solid fuel. But the centralizing force of natural gas is beginning to lose its power. It is being practically demonstrated that manufactured gas and petroleum are able to economically compete with the natural product. Even within the natural-gas territory, shortage of supply and other irregularities have led several glass-makers to turn for their gaseous fuel to manufactories more contemporary than the Devonian gas rock. At Beaver Falls, Pa., for instance, the Co-operative Glass Company was threatened with disaster by the failure of its gas supply. But it turned at once to gas-producers and improved melting furnaces, with results which were highly

satisfactory. What can be done at one place, however, can be done at another. Such cases as these serve to loosen the bond which has heretofore made a geographical and geological unit of the gas-blower's calling. Already this disintegrating force is at work, and there is plainly visible a scattering of glass works. In New England old enterprises are slowly reviving. New plants are being built and projected in New Jersey. In the new South there is much activity. Large works are established in Virginia, at Roanoke and Buena Vista, while others are talked of for Buchanan. A substantial project has taken form at Denver. The Board of Trade Reports of the enterprising cities of the new State of Washington mention glass sand among their natural resources, and look to the speedy establishment of glass-houses in their midst. On all sides is to be seen this delocalization of the industry. For such a large country this seems indeed more like the static condition of affairs, since much of the glass product is too frâgile and too bulky for ready transportation. Another most important tendency has been at work for some years past in the matter of labor organization among the glass-blowers, and is perhaps more potent now than ever. In such concentrated centers of the glass manufacture as Pittsburg the solidarity of labor is doing much to place the economic advantage in the hands of less compact and less affiliated bodies of workers in the outlying districts. Where labor is well organized and so perpetually on the defensive as at Pittsburg the most stringent regulations are forced upon manufacturers in regard to the number of apprentices who shall work at each furnace and attend each master blower. In consequence of this jealous watchfulness, much work which could as well be done by unskilled and less expensive labor must be reserved for those who are duly accredited by the unions and who receive schedule pay. In other districts where Nature has been less kind and trade-unionism less powerful, it is possible to make some of the commoner forms of glassware, such as bottles particularly, at a lower cost than in the more highly favored districts, for the simple reason that the manufacturers are at liberty to employ whom they will, and let unskilled labor do the work proper to it. This is a factor not to be lightly considered, for it is to-day sending business into the hands of out-of-the-way glass-houses, and it promises in the future to be very powerful in determining the course of the industry. It is a vexed question, but, if one is to judge from past industrial history, the victory will not be in favor of solidarity. The desire to hamper and restrict the growth of an industry by saying who shall and who shall not participate in it, is a remnant of the old mediæval guild spirit which is not in harmony with the modern way of thinking. It is much as if farmers attempted to dictate who should and who

should not grow watermelons. The oft-repeated declaration on the part of manufacturers who are bound by trades-union regulations that they can not successfully compete with less favorably located factories free from such dominion is exceedingly significant to the future of glass-making. If it continue, the over-organization of labor promises to defeat its own purpose. The supremacy will pass from the center to the periphery. The scattering of the industry will be forwarded by the selfishness and short-sightedness of labor itself, as well as by those technical and physical conditions which have just been pointed out.

A final glance at the industry shows a manufacture well organized and well developed. It is one full of substantial promise, and full, too, of a power to transform itself greater than it has ever shown before. When the glance extends, as this does, so far back as Jamestown, and includes the long series of disasters which appears to have been the necessary prelude to our present success, the impression grows that, gratifying as this success must be, we have paid a very high price for it. But in this respect glass-making does not differ from the other American industries developed since Columbus.

ARTESIAN WATERS IN THE ARID REGION.

By ROBERT T. HILL.

THE United States Government expends annually over twenty million dollars, mostly in the Eastern half of the country, for the improvement of its rivers, harbors, and other surface waters. The Western half of our domain, which with the exception of the upper coast of the Pacific is known as the arid region, possesses no superabundance of surface waters to improve, but, upon the contrary, the scarcity of water for ordinary domestic and agricultural uses prevents the settlement and utilization of the remaining portion of the public lands. Even the semi-humid or Great Plains region, east of the Rocky Mountain front, has been retarded in development by this scarcity of surface water; and many settlers, who purchased alleged agricultural lands from the Government in this region, are begging Congress to apportion for the investigation of its underground resources a sum at least as large as that given for the smallest creek upon the River and Harbor Bill. Our national legislators have not been entirely neglectful in the matter, however. The rivers of the arid region have been gauged, and the rainfall ascertained, with the disheartening conclusion that, could every drop of the rainfall be utilized, it would still be insufficient to water the fertile

lands. Large sums of money have also been wasted in vainly bombarding the skies for rain, contrary to every known law of Nature. The Department of Agriculture has investigated the underground waters of the Great Plains region east of the Rocky Mountains, but the underground supply of the true American Desert lying between the Rockies and the Sierras has been little studied.

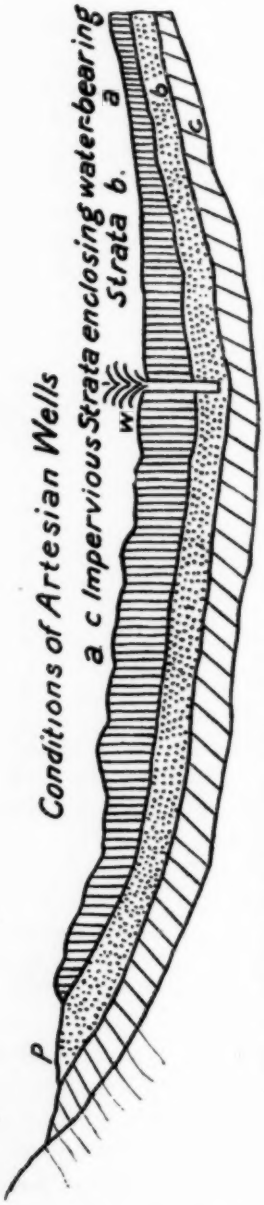


FIG. 1.—PREVALENT CONCEPTION OF ORDINARY ARTESIAN CONDITIONS. Drawn from a Geological Report.

This section includes one fifth the total area of the United States and most of the great central plateau of Mexico. It is marked by peculiar geographic, geologic, and climatic phenomena altogether different from those of the rest of the country, chief of which is the absence of surface water. Streams are rare even in the mountains, and, with the exception of the Colorado, the Snake, and the Rio Grande, not a drop of its surface water reaches the sea, so great is the evaporation and the capacity of the porous desert soils for absorption. Almost any Eastern State has a greater area of surface water than has all the arid region; and the smallest New England brook, could it be transported West, would be a great blessing. In this arid section there are many thousand square miles without a drop of water even for drinking purposes. Nearly every available stream has been appropriated for irrigation by the present population, and all improvement in the water supply must come from underground sources.

It is wrong to encourage anticipations of enormous supplies of underground water where rainfall is so slight; but when we remember that in this region water is of greater value than land, or rather that land is worthless without water, the procurement of even small supplies, sufficient for stock, for irrigating small areas, or for supplying the thirsty locomotive, will be of great value. In view of these facts it is well to understand the laws of the occurrence

and availability of underground waters, for not only have large sums been wasted in boring in unfavorable localities, but impracticable notions have been obtained from scientific treatises on this subject.

The laws of the distribution and utilization of underground water are as simple as those controlling the surface supply, but the popular fallacies concerning them are appalling. The most prevalent of these is that the waters originate at some remote point from their outlet, and flow in subterranean streams like the "blood in the human body," as a farmer once said, and that these streams must be tapped by the well borer or digger before water can be obtained. In nearly every community is some person supposed to possess the art of locating the exact spot above these currents by means of a switch called the divining rod. It is also a current fallacious belief that all underground water is due to rain which falls on the more or less distant mountains, and especially is this true in the region between the Rocky Mountains and the Mississippi, where every spring and well, even on the Texas

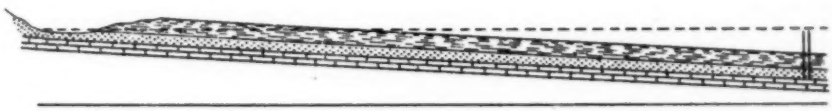


FIG. 2.—FAVORABLE STRUCTURE FOR ARTESIAN WATER, IN WHICH THE RECEIVING AREA IS A VALLEY.

coastal plain a thousand miles distant, is commonly explained upon the hypothesis that the water comes from this lofty range.

These prevalent impressions in the minds of those untrained in geology are more excusable than the widely prevalent idea conveyed by cuts in geological text-books that the usual and ordinary conditions for artesian wells are in great synclinal areas in which the strata can be seen markedly dipping from two including mountain borders against which their edges are upturned as shown in the following figure.

While there is no theoretical objection to this ideal conception, the conditions it represents seldom occur in Nature; on the contrary, as will be shown later, mountain rocks are not the source of great artesian wells; neither do they usually occur in synclinal valleys, but the most favorable conditions are gently sloping monoclinal plains in which the receiving areas, instead of being the upturned mountain rocks, are, in fact, the escarpment valleys of the plains. (See Fig. 2.)

To understand the distribution of earth water, it is necessary to be familiar with the true laws of its occurrence. The rainfall is the source of all underground water, and with the exception of

certain deep-seated artesian wells the source is always the rain which falls in the immediate vicinity, as the physician knows when called to treat disease caused by seepage of the adjacent surroundings into the family well.

Part of the rainfall is quickly drained away by the surface channels, a part is evaporated, and a third, and for our consideration the most important part, is imbibed by the rocks and soil. The proportional disposition of the rainfall in the above manner varies with the climate and geologic conditions, but so far as underground waters are concerned it is necessary to consider only the water which sinks into the ground.

That portion of the earth visible to human inspection, known as the crust, is more or less saturated with water. In times of drought and in the arid region this is not always evident at the immediate surface, where evaporation is taking place, but a post hole, a plow furrow, a blast in a quarry, or a newly dug well reveals the dampness of the rock material. This moisture is sometimes invisible to the eye, but in general its quantity varies in proportion to the compactness or porosity of the rocks, the number of joints, fissures, or other crevices, and the topographic situation which controls the drainage.

If rainfall be long continued, the portion of the crust upon which it falls becomes completely saturated. Upon cessation of the rain, evaporation or drying begins at the surface, causing the line of saturation to sink deeper and deeper. Thus it is that in the Eastern States, where rainfall is excessive and evaporation slow, the line of saturation usually coincides with the surface, while in the arid regions it is often several hundred feet below. In this section, holes three hundred feet deep are often drilled through soil and rock as dry as powder without reaching the line of saturation, while on the East, as for example in New Orleans, water is so near the surface that dry graves can not be dug for the dead.

If the earth were of uniform porosity, temperature, and composition the water it contains would be uniformly distributed through it, as is the water in a well-soaked sponge. But this is not the case, for the outer portion of the globe consists of rocks of much less density than are those of the interior, while the downward percolation of water in some instances encounters the superheated mass of the earth's interior, and is forced back to the surface as steam, as in geysers and volcanoes, or enters into mineral combinations. Hence the available water is confined to that portion of the earth's crust between the lines of heated interior and surface evaporation. Even in this narrow belt the distribution of water is very irregular.

Inasmuch as there is a great diversity of geologic structure,

the possibility of securing water at any given point must be determined by the local formations. All rocks imbibe moisture in proportions varying with their physical structure, a fact which can be demonstrated experimentally by saturating familar types of rocks. Glass is similar in water capacity to large areas of volcanic and other igneous rocks, and will absorb no perceptible amount of moisture; marble will drink in only a slight quantity; while chalk, sand, and brick will absorb nearly their own weight of water. The manner in which rocks absorb water is simple.

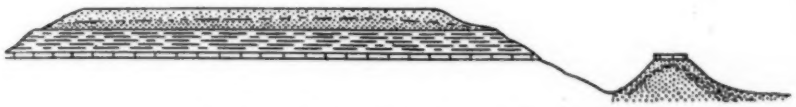


FIG. 3.—MESA STRUCTURE OF LLANO ESTACADO.

In most rocks, however compact to the eye, there exist interstices, cavities, and other spaces in which water may enter and be stored. This is especially true of all sedimentary rocks, which comprise ninety-nine per cent of the earth's crust. A fine sandstone whose grains and intervening spaces are indistinguishable to the eye, when placed under the microscope resembles a mass of cobble-stones in which the spaces occupy as much of the aggregate area as the solid particles. Into a gallon measure of dry pebbles varying in size may be poured half a gallon of water. The consolidated rocks which compose most of the mountain masses are more compact and less adapted for the storage and passage of water than the sedimentary rocks. Nearly all the minerals which compose them are impervious, as is readily seen in a large crystal of quartz, feldspar, or mica. The rocks of valleys and plains usually consist of detrital material less hardened by mountain-folding, and hence more pervious.

Rocks which have imbibed all the moisture they can contain are in a condition of saturation, and all water in excess of this

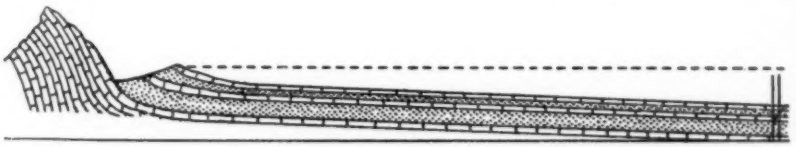


FIG. 4.—ARTESIAN FUNCTIONS OF IMPERVIOUS AND PERVIOUS STRATA.

amount will pass off by gravity or evaporation. The excess above the water of saturation is available as the source of springs, but the supply of wells is from the water of saturation.

Each kind of rock has an individual capacity for the transmission of the water which it has imbibed, and this is entirely

distinct from its capacity for imbibition. If the component particles of a rock—for instance, the quartz pebbles of a loose conglomerate or the grains of a sandstone—present an impervious surface, water will cohere to the individual surfaces until the entire specimen is enveloped in a coat of water. If the interstices are smaller than the average drop of water, the resistance of cohesion to the transmission of water will be greater; hence a chalk or a fine-grained brick will drink in much water, but will transmit it slowly, while water will pass rapidly through coarse gravel. The capacity for transmission in variously grained rocks and the accompanying cohesion is similar to that seen in passing water through sieves of different mesh. Thus, some sandstones of exactly the same capacity for imbibition as chalk transmit water six hundred times faster.

The rock materials of the earth with these different capacities for imbibition and transmission have been sorted into definite sheets or strata by the water which deposited them, and thus another important fact in the question of underground water is introduced—the stratification or arrangement of the rocks relative to one another. Earth water percolates downward through a

FIG. 5.—UNFAVORABLE CONDITIONS FOR ARTESIAN WATER.

porous stratum until an impervious one is reached, while an impervious stratum at the surface will prevent the saturation of a pervious one below. Stratification performs the important function of controlling the distribution of earth water, of resistance, transmission, and storage. If the surface rock stratum is pervious and horizontal, it simply serves as a sponge to hold the water until disturbed by evaporation or seepage, unless the supply is constantly renewed by rainfall. (See Fig. 3.)

If an impervious sheet is above an inclined outcropping porous stratum (Fig. 4), it opposes the tendency of water to rise by hydrostatic pressure and retains it in the porous sheet. If an impervious stratum is beneath a porous one, it prevents the water of the latter from percolating to greater depths. If vertically arranged from folding, the including strata cut off the horizontal transmission of underground water. (Fig. 5.)

Water is transmitted by gravity in the direction of the inclination of the strata—i. e., with the dip; and if the topographic conditions are favorable, flowing wells can be obtained at lower points more or less distant from the outcrop. If the strata in-

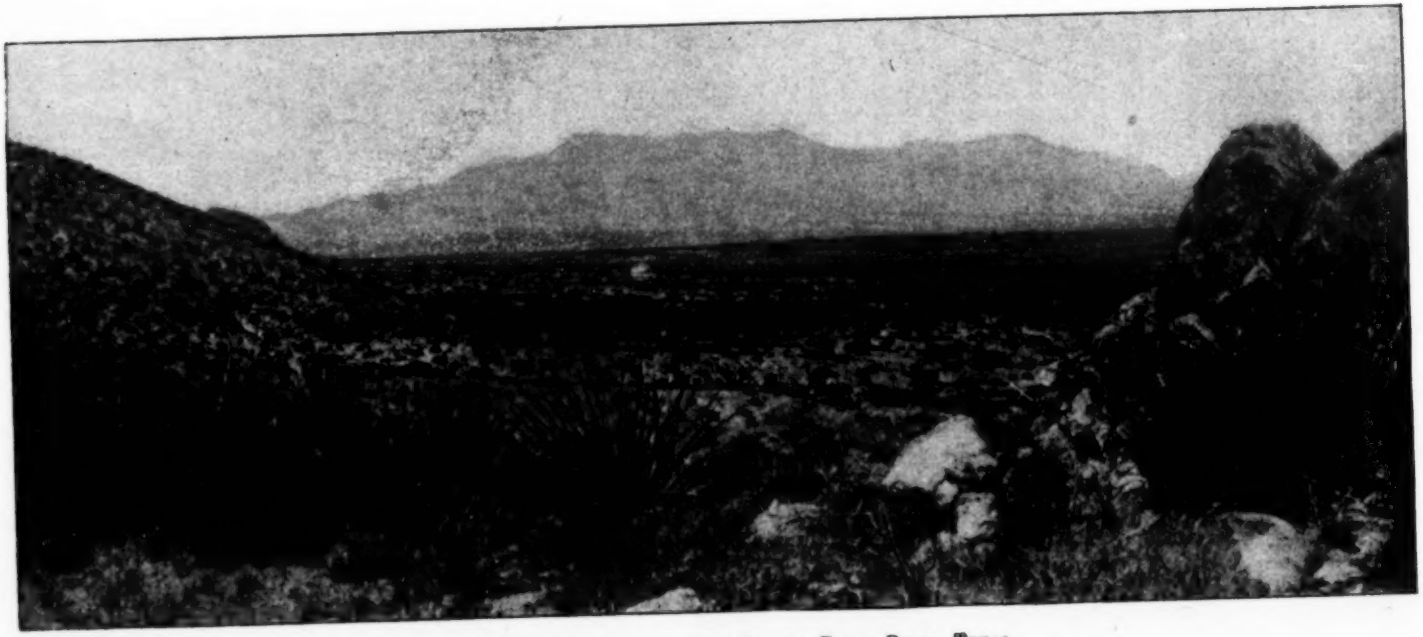


Fig. 6.—Typical Scene in Arid Region, Trans Pecos, Texas.

cline in a direction opposite to the general slope of the country, no matter how favorable the conditions, they will furnish no flowing artesian supply, for water can not rise above the height of the receiving area. (Fig. 5.)

If strata are excessively inclined, as in most mountain regions, artesian wells are improbable if not impossible over any wide area, for the strata soon dip below all available borings; hence the generally accepted idea that artesian wells are peculiar to regions of great stratigraphic dip is fallacious. A dip of one per cent is scarcely visible to the eye, but it will carry a stratum downward 52·8 feet per mile; a dip of ten per cent is hardly noticeable, but will carry a stratum 528 feet in a mile; a dip of forty-five degrees will carry a stratum deeper in a mile than any drill has yet penetrated.

If the earth's surface were level, and a homogeneous mass, earth water would be at a uniform depth throughout, as in an undrained field. But the surface is broken into mountains and plains, and scored by valleys, and the line of saturation sinks toward the level of these, where springs are often found escaping at the level of the streams. There are in Nature two kinds of valleys: (1) Unfinished, or active valleys, which are in the process of being cut out at the present time by the streams seeking base level; and (2) finished, or ancient valleys, which originated in past geologic time, and have been partially refilled with the *débris* of the adjacent region. All the valleys in the mountains proper, and of the eastern United States, belong to the first class, which may be called stream valleys, and their function is to furnish a channel for the passage of the surface waters to the sea. The valleys of the second class, or basin valleys are characteristic of the great arid region, and, with one or two exceptions, they are void of running surface water.

In mountains the surface and underground water is constantly seeking the level of the surrounding valleys, owing to the action of gravity. In general, mountains owe their existence to the superior hardness and imperviousness of their strata, and are of little importance to the problems of underground water.

Basin plains surrounded by the great areas of mountain surface are more favorably situated for the occurrence of underground water in quantity than those with a smaller surrounding area of mountain slopes, for impervious mountains serve to concentrate the rain-water which runs down their slopes upon the pervious valleys, thereby increasing the available water supply beneath the latter. (Fig. 6.)

The water of saturation in *buttes* and *mesas*, which usually consist of horizontal strata, is reduced by gravity toward the level of the surrounding plain, or, when alternations of pervious and

impervious strata occur, the water seeps out as springs at their contact. The Llano Estacado, or great Staked Plain of Texas and New Mexico, is the largest of all the American *mesas* in area. Its geological structure is practically that shown in Fig. 3, consisting of a pervious surface formation, averaging three hundred feet, resting upon a foundation of impervious clays and other rock. The upper formation readily imbibes all the surface rainfall; hence the region is void of running streams.

Throughout this large area, once considered hopelessly void of water, good non-flowing wells are now everywhere obtained by boring to the lower depths of the saturated, sponge-like surface formation, while springs occasionally break out at the margin of the plains where the two formations are in contact.

While water-bearing strata should always be porous, and usually are but slightly if at all consolidated, the degree of consolidation has but little bearing upon the retaining function of impervious strata. Soft clay shale is practically as impervious as hard slate. In the West many people discredit the possibility of artesian water in many favorable localities, because of the absence of consolidated strata which they suppose are necessary to constitute the impervious stratum above the one containing the water. In fact, the less consolidated the rocks of a region are, the more favorable are the artesian conditions; and, inasmuch as the older formations of the earth are more consolidated, metamorphosed, and disturbed by greater tilting, faults, and folds, they are least favorable for the occurrence of artesian water. Upon the other hand, the later formations present the opposite and more favorable conditions, and with few exceptions the great artesian wells of the world are found in them. These later rocks play an important part in the geology of the arid region.

The adjoining section from the Gulf of Mexico to the Rocky Mountains, from Galveston to Las Vegas, New Mexico, illustrates some of the principles herein set forth. From the coast to the ninety-seventh meridian is a large series (*a*)

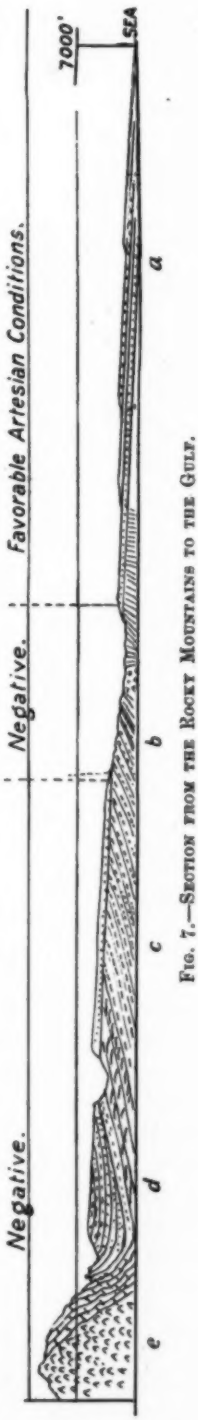


FIG. 7.—SECTION FROM THE ROCKY MOUNTAINS TO THE GULF.

FIG. 8.—BASIN AND MOUNTAIN SCENERY OF ARID REGION, SOUTHWEST NEW MEXICO. From Mexican Boundary Report.

of alternations of porous and impervious strata of the later geological ages, dipping at an almost imperceptible angle toward the sea and accompanied by slight scarp valleys along their western outcrop, which are the receiving areas for the artesian waters. The Atlantic coast plain from New Jersey to the Rio Grande nearly everywhere presents similar conditions, and abundant artesian wells have been obtained. This group of rocks rests upon another series of older rocks (*b*, *c*), which presents negative conditions for artesian water, owing to their inclination in a direction opposite to that of the topographic slant. No artesian wells of large flow have been, or are apt to be, obtained in this region. Above the west part of this series is the great *mesa* of the Llano Estacado (*d*), the non-flowing wells of which have been explained. A second negative area is shown in the portion of the diagram in northeastern New Mexico (*d*), where the inclination of the strata is again opposite to that of the topographic slant. Where the front of the Rocky Mountains appears (*e*), the principle that the mountain rocks are unfavorable for artesian conditions is shown by the faulting and excessive dip of the strata.

Let us now briefly examine the bearing of the foregoing principles on the question of underground water in the great arid

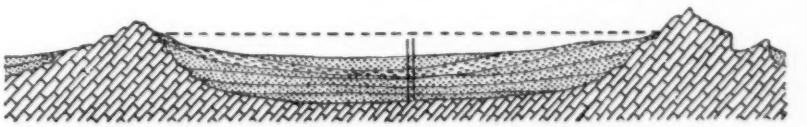


FIG. 9.—FILLED-IN VALLEY OF ARID REGION.

region proper, west of the Rocky Mountain front. Topographically this country, from the union of the Cordilleras in southern Mexico to the British boundary, consists in alternations of mountain and desert plain (Fig. 8). The mountains are isolated masses of hard, impervious rock, broken by faults, and dipping at angles which render the strata unpropitious for artesian exploitation. The wide areas of desert plain separating the mountain masses are of the older type of valleys described on a previous page, which are now filled to a depth of two thousand feet by the detrital deposits from the adjacent mountains (Fig. 9). The original valley floor, consisting of mountain rock, is entirely obscured by these deposits, and of no value to the artesian possibilities. The rainfall upon the mountains is rapidly shed by cañon-streams and *arroyos* to the level of the adjacent valleys, where it sinks into the ground, owing to the thirsty character of the valley formation, and gravitates downward toward the lower and usually central depths of the deposit, the underlying floor of mountain rock serving as a

bottom for the retention of the water in the valley deposits. So great is the capacity for imbibition of these desert plains that every drop of rain upon them, except such as is evaporated, is quickly drunk in, and all the mountain streams of the vast region, with three exceptions, completely disappear upon reaching them, and are known as "lost rivers" in the parlance of the West. Under the old erroneous idea that the mountain rocks contained the artesian waters, many hundred futile and costly experiments have been made by the Government, railroad corporations, and private individuals, in boring wells at the margins of these deserts, where the mountain rock was seen disappearing beneath the valley deposit, instead of seeking the lowest topographic point in the

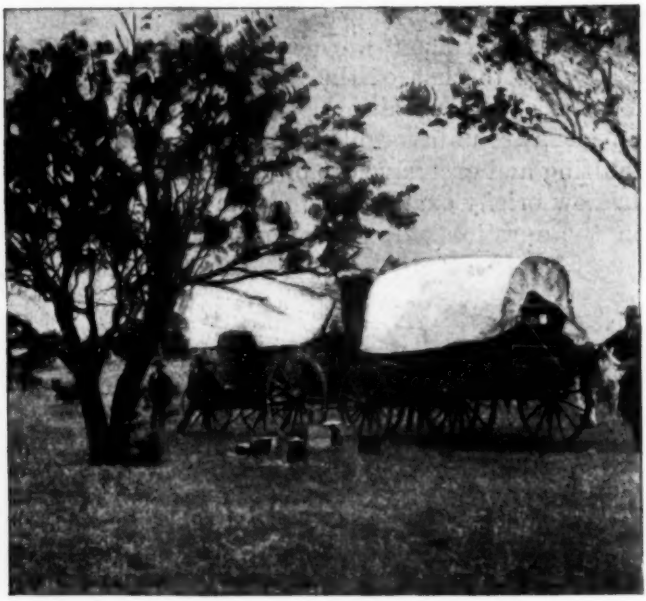


FIG. 10.—DESERT TRAVELERS.

plains, and relying upon the unconsolidated formation of the desert as the probable source of water.

Within the past few years there have been many accidental demonstrations of this principle; and when it is generally understood, it is probable that in nearly every one of these now useless waste places at least a small quantity of water will be secured, and in many instances good flowing artesian wells. Wells of this character have been procured in great number in California, at Riverside and in the San Joaquin Valley, not one of which penetrates to the underlying floor of impervious mountain rock, but are all secured in the detrital valley deposit. Similar wells have been found in numbers in the Great Salt Lake Desert of Utah, and

a few in the deserts of Nevada. In Mexico they are obtained in the valley deposits of the city of Mexico, the Lake Chapala basin of Jalisco, and could be secured at many other points. The grandest demonstration of the principle, however, is found in the famous San Luis Park of Colorado. It is true that this valley, owing to the large area of mountains surrounding it, has an unusual number of "lost rivers" supplying water to the valley deposits from which over thirty-seven hundred flowing wells have been obtained. Less than ten per cent of these attain a depth of seven hundred feet, and barely fifteen per cent reach four hundred feet. On the great La Noria Desert, stretching for one hundred miles northeast of El Paso, Texas, between the Organ and Franklin ranges, which is void of a drop of surface water, abundant supplies of underground water are now procured at a depth of two hundred feet, and are pumped by windmills for irrigating purposes.

The wells of all these localities were drilled haphazard, without reference to the geological principle we have endeavored to describe. If this principle could be made known that the underground waters of the arid region are stored in the desert deposits, and not in the mountain rocks, there is no reason to doubt that wells could be procured in most of these innumerable wastes of the arid region, which would at least suffice for the passing traveler, and in many cases supply water for live stock and irrigation, sufficient to supply the necessaries of life to the mining populations of the adjacent mountain regions.

ACCORDING to M. V. Brandicourte, of the Linnæan Society of the north of France, the *Eucalyptus alpina*, once abundant in Mount William, Australia, is now known only by a single specimen in the botanical garden of Melbourne; *Psiadia rotundifolia*, a tree of the composita of St. Helena, is reduced to a single natural specimen and a few cultivated ones at Kew. No living representative is now known of the dwarf palm (*Chamærops humilis*) which once grew near Nice. The orchid *Spiranthes Romanzoviana* has apparently disappeared from the meadow in Ireland which was its only known station. Some fifty species have disappeared, or nearly disappeared, from the department of Sonne, in France. Most of this devastation is the work of amateurs, horticulturists, or botanists.

A PARTY of Chinese traders who recently visited the interior of southern Formosa have brought back, according to Mr. D. J. MacGowan, stories which remind one of the fairy tales or of the fancies of the Arabian Nights. They lodged in stone caverns, and the chattering of monkeys and the sounds of insects seemed to them "appalling and indescribable." The region was so weird that it reminded them of "legends of the kingdom of hobgoblins." They describe forests of trees of "prodigious girth," some of them measuring more than ten outstretched arms; and a tree flourishing in those forests that bears "flowers, red and white, which are larger than a sieve and of extraordinary fragrance." The flowers thus described are supposed to be epiphyte orchids.

WHITE SLAVES AND BOND SERVANTS IN THE PLANTATIONS.

By Colonel A. B. ELLIS,
TOWER HILL BARRACKS, SIERRA LEONE, WEST AFRICA.

FEW but readers of old colonial state papers and records are aware that between the years 1649 and 1690 a lively trade was carried on between England and the "plantations," as the colonies were then termed, in political prisoners, who were sentenced to banishment in the former country and shipped to the colonies, where they were sold by auction to the colonists for various terms of years, sometimes for life, as slaves.

The government of the Commonwealth appears to have been the first to adopt this convenient if unjustifiable method of disposing of troublesome adversaries; and in Cromwell's proclamation to the Irish people, dated Youghal, January, 1649, and written in answer to the declaration of the Irish prelates at Clonmacnoise, we find the following: "The question is of the destruction of life, or of that which is but little inferior to it—to wit, of banishment. Now, first, I shall not willingly take or suffer to be taken away the life of any man not in arms, but by the trial to which the people of the nation are subject by law for offences against the same; and, secondly, as for the banishment, it hath not hitherto been inflicted on any but such who, being in arms, might justly upon the terms they were taken under have been put to death, as might those who are instanced in your declaration to be 'sent to the Tobacco Islands.'" And in a dispatch from Cromwell to the "Hon. William Lenthall, Esq., Speaker of the Parliament of England," dated September 17, 1649, and describing the storming of Drogheda, we find with reference to those men who, contrary to the custom of war, had continued their resistance after the place had been carried and quarter given: "When they submitted, these officers were knocked on the head, and every tenth man of the soldiers killed; and the rest shipped for the Barbadoes."

Banishment, however, was not a punishment reserved for the Irish taken in arms against the Commonwealth, for the same measure was meted out to Englishmen and Scotchmen who incurred the displeasure of the Protector; and the "Tobacco Islands"—namely, St. Christopher, Nevis, and Barbadoes—did not enjoy a monopoly of this traffic, for prisoners were sent in large numbers to the New England colonies, and, after the capture of Jamaica from the Spaniards, to that island. Of the ten thousand Scottish prisoners who were taken at the battle of Dunbar, five thousand were dismissed on account of sickness and other causes,

and the remainder marched to Durham and shipped for North America and the West Indies. How those who reached the former country were disposed of we learn from Hutchinson's Papers relative to the History of Massachusetts (Boston, 1769), in which is a letter from the Rev. John Cotton to Oliver Cromwell, as follows: "The Scots whom God delivered into your hands at Dunbar, and whereof sundry were sent hither, we have been desirous as we could to make their yoke easy. Such as were sick of the scurvy or other disease have not wanted physic and chirurgery. They have not been sold for slaves to perpetual servitude, but for six or seven or eight years, as we do our own; and he that bought the most of them, I hear, buildeth houses for them, for every four a house, and layeth some acres of ground thereto, which he giveth them as their own, requiring them three days in the week to work for him by turns and four days for themselves, and promiseth as soon as they can repay him the money he laid out for them, he will set them at liberty."

The lot of these unfortunate Scots was pitiable enough, but it seems they were treated with far more consideration than their follow-sufferers in the West Indies. In Massachusetts, too, to judge from the foregoing letter, the purchaser could terminate the period of slavery when he wished; but in the West Indies the banished were sentenced to specific terms of servitude which could not be shortened; and where no term was mentioned the slavery was, before the law of 1681 (33 Charles II), for life. There is still in existence in Jamaica a deed executed in the secretary's office in November, 1671, between Robert Nelson and Thomas Pitts, by which the former, in consideration of the sum of £10, conveys to the latter and his heirs forever one white servant named Stephen Ayliff.

As we have said, Englishmen were likewise banished, and a great many of the royalist party who took part in the abortive rising of Wagstaff and Penruddock at Salisbury in March, 1655, were sent to Jamaica and Barbadoes, with reference to whom Carlyle says: "A terrible Protector this. . . . He dislikes shedding blood, but is very apt to 'barbadoes' an unruly man—has sent hundreds and hundreds to Barbadoes, so that we have made an active verb of it, 'barbadoes you.'"

After the Restoration, Charles II did not scruple to use against his political opponents a weapon which they had employed so effectually against his party. The House of Commons which was returned by the general election of 1661 revived the old ecclesiastical policy and recommenced the persecution of Nonconformists, a series of penal statutes against them being passed and assented to by the king, in spite of the promises he had publicly made, both before and after his restoration, to grant liberty of conscience to

all men. It was made a crime to attend a Dissenting place of worship. A single justice of the peace might convict without a jury, and might, for the third offense, pass sentence of transportation beyond the seas for seven years. With refined cruelty it was provided that the offender should not be transported to New England, where he was likely to find sympathizing friends. If he returned to his own country before the expiration of his term of exile, he was liable to capital punishment.*

Charles II made Jamaica one of the places of banishment for the Quakers, who would take no oaths either abjuring papacy, acknowledging the supremacy of the king, or swearing allegiance to him, all which omissions were considered to be treasonable offenses, and hundreds of them were sentenced as convicts and sent out. These were soon followed by the conspirators of the Whig and Rye House Plots in 1683, and in 1684 the Jamaica House of Assembly passed by command an act entitled "An act for ascertaining the servitude of the rebels lately sent from England, and to prevent all clandestine releasements and buying out their time, to the end, that after so great a mitigation" (as reprieve from hanging) "their punishment might yet in some measure be answerable to their crime." The author of the Annals of Jamaica informs us that these poor wretches were sentenced to ten years' servitude, and adds that few lived to its expiration, as may be readily believed when we remember that they were employed as "field hands" in a climate that at that time was notoriously unhealthy for Europeans, were insufficiently fed, badly housed, and hard worked.

In the reign of James II this inhuman practice was still continued. More than three hundred persons who took part in, or were suspected of being connected with, the rising in Argyleshire, were transported to the West Indies, many of them having first been subjected to mutilation; and several women were banished, after being branded on the cheek with a hot iron. The prisoners taken at the battle of Sedgemoor in 1685, and persons otherwise implicated in the rebellion of Monmouth, who were all technically liable to suffer death, were granted in batches to the members of the court, who sent them out to the colonies to be sold as slaves. The number of prisoners transported by the notorious Judge Jeffreys was eight hundred and forty-one. They were divided into gangs and granted to court favorites, the conditions of the grant being that the convicts should be carried beyond the sea as slaves, that they should not be emancipated till after ten years, and that the place of their banishment should be the West Indies. This last condition was studiously framed for the purpose of aggravat-

* Macaulay.

ing the misery of the exiles, for it was thought that in New England they would have found a population kindly disposed toward them. The stipulation, however, that the place of banishment should be a West India island was not in every case complied with, for some of the exiles certainly found their way to Virginia; and a letter addressed to the government of Virginia on the subject of the convicts says: "Take all care that they continue to serve for ten years at least, and that they be not permitted in any manner to redeem themselves by money or otherwise until that term be fully expired. Prepare a bill for the Assembly of our colony with such clauses as shall be requisite for this purpose." Less compliant than the Jamaica Legislature, which, as we have seen, had passed by command a similar act the year before, the Virginia Legislature appears never to have passed the measure sought to be forced on it, and at the accession of William and Mary all the exiles were set free.

Such was the condition of the slave market at this time that the convicts, notwithstanding the high rate of mortality during this, the earliest "middle passage," were very valuable in England. From a letter addressed to James II by Judge Jeffreys, protesting against the sycophants of the court sweeping up all the spoil, we learn that they were considered worth £15 apiece. He says: "I beseech your Majesty that I may inform you that each prisoner will be worth £10, if not £15, apiece; and, sir, if your Majesty orders these, as you have already designed, persons that have not suffered in the service will run away with the booty." The royal party in Somerset and the western counties pointed out that by the losses they had sustained during the rebellion, and by their exertions in its suppression, they had earned a right to share in this profitable speculation; but the king turned a deaf ear to their expostulations, and the court favorites remained victorious. The queen did not disdain to share in the profits of this inhuman business; and, instead of endeavoring to save even one single victim from this most frightful proscription, the only request that she is known to have preferred touching the rebels was that a hundred of those who had been sentenced to transportation might be given her. Macaulay declares that the profit which she cleared on the cargo, after making large allowance for those who died during the passage, can not be estimated at less than a thousand guineas. Of the horrors of the passage itself he says: "The misery of the exiles fully equaled that of the negroes who are now carried from Congo to Brazil. It appears from the best information which is at present accessible, that more than one fifth of those who were shipped were flung to the sharks before the end of the voyage. The human cargoes were stowed close in the holds of small vessels. So little space

was allowed that the wretches, many of whom were still tormented by unhealed wounds, could not all lie down at once without lying on one another. They were never suffered to go on deck. The hatchway was constantly watched by sentinels armed with hangers and blunderbusses. In the dungeon below all was darkness, stench, lamentation, disease, and death. Of ninety-nine convicts who were carried out in one vessel, twenty-two died before they reached Jamaica, although the voyage was performed with unusual speed. The survivors when they arrived at their home of bondage were mere skeletons. During some weeks coarse biscuit and fetid water had been doled out to them in such scanty measure that any one of them could easily have consumed the ration which was assigned to five. They were therefore in such a state that the merchant to whom they were consigned found it expedient to fatten them before selling them."

John Coad, an honest carpenter, who joined the rebellion under Monmouth, was badly wounded in the skirmish at Philip's Norton, and tried by Jeffreys and sent to Jamaica, where he appears to have fared better than most of his fellow-exiles, has left us a narrative from which the reader may gather many curious particulars. He and those who were shipped with him were consigned to a Mr. Christopher Hicks, of Port Royal, Jamaica, who at first, having some Nonconformist leanings, refused to sell them; but on its being represented that if he declined that office it would only be filled by some one else, and that he might be instrumental in getting them good places, he consented to put them up to auction. The hour at which the market opened for the sale of the convicts was announced by the firing of a gun, and John Coad, more fortunate than some of his fellow-sufferers, passed into the hands of a humane planter with whom he was secure from ill-treatment, and in whose service he passed five years of his servitude. Immediately after the Revolution, and the elevation to the throne of William and Mary, a new governor, the Earl of Inchiquin, was sent to Jamaica, with instructions to release from their bondage and send to England such of the exiles as were still alive. This news spread rapidly among the convicts, and some of them went to the Governor to inquire about their freedom. The earl, who appears not to have read his instructions, and to have been of a choleric and hasty temper, had the deputation flogged and sent away; but was astonished to find, a few days later, that the men he had thus ill-treated were those who were specially recommended for kind treatment. He accordingly summoned the Council and proclaimed the freedom of all the exiles, who, after some little delay, were finally shipped home.

The participators in Monmouth's rebellion were the last who were ever sold into bondage beyond the seas and consigned to

slavery, and the reception met with by those who went to interview the Governor will give us some idea of the manner in which exiles were usually treated. In most cases, in the West Indies, they were herded with the negro slaves, insufficiently fed, ill-clad, compelled to sleep without beds on the earthen floors of the hovels that were provided for them, driven out to work daily under a tropical sun, and flogged for the most trivial offenses. Scores of them succumbed to this treatment, and it must be remembered that these men were not malefactors, nor indeed criminal at all, except in a political sense. Most of them were men of blameless lives, and, as says Macaulay, they were regarded by themselves, and by a large proportion of the people of England, not as wrongdoers, but as martyrs who sealed with their blood the truth of the Protestant religion.

So much for the white slaves; we now turn to the bond-servants—that is, persons who engaged themselves as servants in the colonies for a certain number of years, and whose condition was little better than that of the convict-slaves. It is true that the bond-servant came to the colonies voluntarily, in theory at least, for in fact he was often a poor wretch who had been kidnapped in some English seaport and hurried on board a vessel, while the convict was banished; but, once in the colonies, there was little distinction made between them. Indeed, their position in most of the colonies was such that it is incredible that any persons should knowingly have engaged themselves; and we are forced to conclude that they were not informed of the conditions of their servitude, and were misled by false representations made by the agents of the colonists in England.

Each colony appears to have had its own law on the subject of bond-servants. That of Jamaica provided that bond-servants might be of either sex, and those who had not entered into contracts or agreements in England were compelled, after arriving in the island, to serve seven years if they were under eighteen years of age, and four years if they were above that age. The clause of the act ran thus: "All servants shall have according to their contract and indenture; and where there is no contract and indenture servants under eighteen years of age, at their arrival in this island shall serve seven years, and above eighteen years, shall serve four years, and all convicted felons, for the time of their banishment; and at the expiration of the terms aforesaid, shall receive from their last master, mistress, or employer, forty shillings, and a certificate of freedom on demand; and whosoever shall refuse, without just cause, to give such certificate to servant, certifier, or labourer, whose time is expired, shall forfeit forty shillings for every such refusal." The words "certificate of freedom" smack rather of slavery, and the bracketing together of convicted felons

with bond-servants, as if they were much the same kind of persons, gives us a hint at the social position of the latter. In fact, the bond-servant was little better than a slave. No person was allowed to employ a servant who was not possessed of a certificate of freedom from his last employer, or to buy from or to sell to any servant any kind of article whatever, without the consent of the master or mistress, under penalty of forfeiting to the owner treble the value of the article bought or sold, and £10 of the island currency. Any servant who offered violence to his or her employer was compelled to serve an additional twelve months, without wages, for each offense; and if a servant stole, made away with, or wasted any of his employer's property to the extent of over forty shillings, he was to serve two additional years without wages. For each day of absence from work the servant was to serve a week, but additional services on this ground were not to exceed a total of three years.

Any man-servant who married without the consent of his employer was to serve two additional years for the offense, but if a free man married a servant he was to pay the employer £20 and the servant was free. If a free man had an illegitimate child by a servant, he was to pay £20 to the employer, and to provide for the maintenance of the servant and child, or, in default, was to serve the employer double the time the servant had still to serve; while if one servant had a child by another, the man-servant, after serving his own time, had to serve double the time the woman had to serve when the offense was committed.

If any one knowingly entertained a servant, he was liable to a fine of £5 for each day and night; if it was done without knowledge the fine was £1. If one servant was guilty of entertaining another servant, he was to forfeit a year's service, or receive thirty-nine lashes on the bare back, at the option of the party injured. Any person who forged a certificate of freedom was to be subjected to the punishment of the pillory, and to the loss of his ears. Any servant who permitted any one to ride his master's horse, or use his cart, was to serve an additional three months for each offense.

These were the clauses of the act framed for the protection of the employers of bond-servants; those designed for the protection of the servants were much fewer, and their purport was as follows: Should a servant fall sick, he or she was to be provided for, under a penalty of £20; but if the servant's sickness arose from misconduct, or from indiscretion, or if it was the yaws or a broken limb, he or she was to serve double the time lost. No servant was to be flogged naked without a justice's order, under a penalty of £5; and no servant could be buried until the body had been seen by a justice, constable, or tithingman, or by

two neighbors. This last provision was framed to prevent servants, who had been murdered or who had died from the effects of ill-treatment, being buried quietly and the matter hushed up. The owner was bound, under a penalty of ten shillings, to provide each white servant weekly with four pounds of meat, or four pounds of fish, with such vegetables "as may be sufficient." Owners were further bound to give yearly to each man-servant three shirts, three pairs of drawers, three pairs of shoes, three pairs of stockings, and one cap, and to a woman-servant in proportion.

Such was the law governing the relations between bond-servants and their employers in the island of Jamaica, and so far from being exceptional it compares favorably with others. The object of the law was clearly the prolongation of bond-service, most offenses being punishable by additional terms of servitude; and the master consequently had an interest in their committal, and not infrequently provoked the servant to commit them. It can scarcely be believed that any one should knowingly have expatriated himself to serve under such conditions as these in a country which then bore a very unenviable reputation for unhealthiness; and it is fairly certain that those who came voluntarily must have been ignorant of the law; but a very large proportion of the bond-servants were carried off from England by force, and such kidnapped laborers are those who are referred to in the act as persons arriving without a contract or indenture. In 1682 large numbers of laborers were seized in England and shipped to Jamaica, and the fact was so notorious that an order in Council was issued regarding it. In 1685 kidnapping had become very common in Bristol, and young persons, guilty of no offense, were seized, hurried across the Atlantic, and sold for money. Even the city magistrates dabbled in this kind of traffic. At that time many offenses which are now considered very trivial were punishable with death, and it was the practice of the mayor and justices to intimidate persons brought before them, and to induce them, under fear of being hanged, to pray for transportation; the profits of the business being divided among the members of the magistrate's court. In connection with this scandalous abuse, Judge Jeffreys appears for once in a light which is quite novel to most readers of history—viz., as the champion of the liberty of the subject, and a redressor of grievances; for, chancing accidentally, when at Bristol, to discover the proceedings of the mayor, he, when sitting as judge, took the opportunity of denouncing him, and compelled him to plead for mercy at the bar.

Kidnapping was not limited to England, as we learn from the pages of Esquimeling, servant of Morgan, the notorious buccaneer, and author of the History of the Buccaneers, who had him-

self been a bond-servant and had twice been sold. He tells us that the bond-servants were usually treated worse than the negro slaves, for, as the latter were the actual property of their masters, they took some care to preserve them. After describing the situation of the bond-servants in the islands belonging to France, and saying that he has seen bond-servants beaten to death in the French portion of Hispaniola, now Hayti, he thus continues: "The planters that inhabit the Cariby Islands are rather worse and more cruel to their servants than the precedent. In the Isle of St. Christopher dwelleth one, whose name is Bettesa, very well known among the Dutch merchants, who hath killed above an hundred of his servants with blows and stripes. The English do the same with their servants, and the mildest cruelty they exercise towards them is that, when they have served six years of their time (the years they are bound for among the English being seven complete), they use them with such cruel hardship as forceth them to beg of their masters to sell them unto others, although it be to begin another servitude of seven years, or, at least, three or four. I have known many who, after this manner, served fifteen and twenty years before they could obtain their freedom. . . . To advance this trade, some persons there are who go purposely to France (the same happeneth in England and other countries), and, travelling through the cities, towns, and villages, endeavour to pick up young men or boys, whom they transport, by making them great promises. These having once allured and conveyed them into the islands I speak of, they force to work like horses, the toil they impose upon them being much harder than what they usually enjoin unto the negroes their slaves."

A terrible indictment of seventeenth-century planters this, and on the whole, except perhaps in the actual number killed by the Dutchman Bettesa, not an exaggerated one, for we find General Brayne, who arrived in Jamaica as governor in December, 1656, urging Cromwell to have negro slaves imported from Africa, on the ground that, as the planters would have to pay for them, they would have an interest in the preservation of their lives, which was wanting in the case of bond-servants, numbers of whom were killed by overwork and cruel treatment.

THE little village of Payerne, near the Lake of Neubourg, Switzerland, possesses a unique curiosity in the shape of the saddle of Queen Bertha, who founded the Abbey of the Benedictines at Neubourg, now converted into an educational establishment, in A. D. 961. The saddle is of marked antique shape, and has an opening on the pommel, which was intended to hold the lady's distaff; for the good queen would not lose a moment of her time, and set a profitable example to her subjects by busying herself with spinning while she was on horseback.

THE DECREASE OF RURAL POPULATION.

By JOHN C. ROSE.

WHEN the Constitution of the United States was adopted, only one in every thirty of the people who ordained and established it were residents of cities or towns having eight thousand inhabitants or upward. There were but six such places in the entire country. San Francisco, situated sixteen hundred miles west of our then western boundary, and not founded until nearly sixty years after Washington was inaugurated, has now more than twice as many inhabitants as had all the cities of the United States together when the first census was taken. To-day we think and speak of such States as Kansas, North Carolina, Texas, and Arkansas as almost purely agricultural States. On such political questions as the tariff and the currency we expect to see their representatives take such positions as the farmers, whether rightly or wrongly, suppose will best promote their interests. Yet every one of the States just named, and indeed every State east of the Missouri River, with the single exception of Mississippi, has a larger proportionate urban population than had the country as a whole when Hamilton carried through Congress his measures to levy duties on imports for the "support of government, for the discharge of the debts of the United States, and the encouragement and protection of manufactures"; to make "provision for the debt of the United States," and "to incorporate the subscribers to the Bank of the United States." So great and far-reaching are the differences between the social, economic, and political conditions of city and country communities that there are few features of the eleventh census which are more deserving of close study than those which show how rapidly the United States is changing from an almost purely rural to what promises ere long to be a predominantly urban country.

In making such a study the first thing to do is to determine where the necessarily arbitrary line between urban and rural shall be drawn. For the purpose of this article, all cities, towns, and villages which were separately returned by the census as having on June 1, 1890, 1,000 inhabitants or upward, are considered as urban communities. There were 3,715 such cities, towns, and villages; and when hereafter in this article mention is made of "urban population," the population of these places is intended, while the term "rural population" will be used to designate all the inhabitants residing outside of such cities, towns, and villages. Of course, this division is not only arbitrary, but to a certain extent, particularly in New England, it may be misleading as well. There are in the New England States 411 towns of between 1,000

and 2,000 inhabitants, and 209 of between 2,000 and 4,000 inhabitants each. Of the former class the majority were doubtless largely if not altogether rural communities, as were many of the latter; and considerable rural population is often included in New England towns with a still greater aggregate number of inhabitants. The impossibility of drawing as hard and fast a line between the rural and urban or semi-urban population in New England as may be done in the other portions of the country is of course due to the fact that while geographically the towns in New England correspond to the towns, townships, election, militia, or magisterial districts, hundreds, wards, precincts, beats, etc., into which the counties in the other parts of the country are divided, it is in New England very unusual to incorporate a village or borough within a town. When separate government is desired by a portion of a New England town, the more common practice is to set off the area asking for it as a new town. It is not possible to determine with mathematical precision the precise increase during the decade of the 3,715 places having each over 1,000 inhabitants in 1890. In a number of instances the territorial limits of cities and towns were not the same in 1890 as in 1880. Usually, of course, when changes have occurred there have been extensions of corporate boundaries. Among the smaller towns and villages there are many whose population in 1880 was not separately returned. In some instances the places did not exist in 1880, but more frequently their not being mentioned in the census was due to failure of the enumerators to separate their inhabitants from the persons residing in other portions of their census districts Both the circumstances last mentioned would operate to make the apparent increase in the population of the cities and towns greater than it actually was. On the other hand, many of the larger cities are surrounded by more or less extensive belts of territory outside of their corporate limits, the increase of the population of which belts is due entirely to the growth of the cities around which they lie. On the whole, therefore, it is believed that to compare the population as returned by the eleventh census of cities, towns, and villages of 1,000 inhabitants or upward in 1890 with the population of the same places as returned in 1880 will afford a practically accurate measure of the rate of growth of the city, town, and village population of the country as a whole. In particular States, however, one or the other of the above causes of error may so predominate as to exert an appreciably disturbing influence on the accuracy of the comparison. In local comparisons, therefore, proper allowance has been made whenever necessary for the operation of these causes. The increase of the rural and urban population, as above defined, during the decade has been:

	United States.	Urban.	Rural.
1890	62,622,250	26,142,025	36,480,225
1880	50,155,783	17,775,076	32,380,707
Increase	12,466,467	8,366,949	4,099,518
Percentage of increase	24·86	47·07	12·66

In 1880 the 3,715 places which in 1890 had more than 1,000 inhabitants each, had but little more than half as many inhabitants as resided outside their limits, yet during the decade their absolute increase was more than twice as great as was that of the rest of the country, and relatively nearly four times as great. Striking as this difference is, it tells only a small part of the story; for such increase as there was, was confined almost entirely to the portions of the country hitherto altogether unsettled or but scantily peopled.

In northern Maine, in the Adirondacks in New York, in northern Michigan, Wisconsin, and Minnesota, in southern Florida, in the Dakotas and Texas, and in nearly all the States and Territories west of the Missouri, large areas of hitherto unsettled land received inhabitants. The settled area, by which phrase the Census Office means the area on which there is a population of at least two to the square mile, increased during the decade 377,715 square miles, or more than the entire settled area of the country at the beginning of this century, and nearly as much as the areas of France and Germany combined. Almost three millions of the entire four millions of increase in rural population was in the States west of the Mississippi, and the remainder was in the comparatively thinly settled States south and west of Virginia and in northern Michigan and Wisconsin. Speaking generally, it may be said that there was an absolute decrease in the rural population of all the more densely populated agricultural regions of the country.

The diminishing population of rural New England has long been the subject of melancholy comment. During the last decade no less than 935 of its 1,592 cities, towns, and plantations, whose population was separately returned both in 1880 and 1890, lost inhabitants. Of these 935 no less than 814 were towns or plantations which in 1880, and of course in 1890, had less than 2,000 inhabitants, or in other words were mostly rural places. The aggregate population of the 1,246 towns, plantations, and "gores," which in 1890 had each less than 2,000 inhabitants, in 1880 and 1890 compared as follows:

1880 population	1,050,060
1890 population	977,830
Decrease in decade	72,230
Percentage of decrease	6·88

Certainly in Massachusetts, in which State I have carefully examined the returns of the towns at every Federal census, and in some of the other New England States probably, this decrease of the population of the smallest and most purely rural towns—that is, of those which had in 1890 less than 1,000 inhabitants each—has been going on steadily ever since 1840, and they now have less population than they had ninety years ago. The next larger towns, still purely or nearly purely rural, but more favorably situated, being those which had in 1890 between 1,000 and 2,000 inhabitants each, increased steadily and with a reasonable degree of rapidity until 1850. During the decade between 1850 and 1860 there was a barely perceptible increase, and since 1860 the decrease has been continuous. In the aggregate all the towns having less than 2,000 inhabitants each, comprising as they do 179 of the 351 towns and cities in the State, had a larger population in 1820 than they have to-day.

In the early days of the century, railroads there were of course none. Even canals as yet existed principally on paper. The cost of land carriage was on the average probably at least twenty-five times as great as it now is. Articles whose bulk was large as compared with their value, as is generally the case with agricultural products, could not profitably be carried great distances overland. Under ordinary circumstances, if they could not be consumed or reach navigable water within a hundred and fifty miles or less of the place of their origin, they were practically valueless. Under such conditions the proximity of most of the New England country towns to the seacoast and to the commercial and manufacturing centers gave them an enormous geographical advantage, which went far to compensate for the comparative sterility of much of their soil. Now, however, when it costs less to bring a barrel of flour or a bushel of wheat from Nebraska or the Dakotas than it did eighty years ago to wagon like articles a hundred miles, those advantages which were once so great have become of little practical importance. Were the decrease of rural population confined only to New England and to such portions of the other older States as had a soil below the average of productiveness, the phenomenon would have a very obvious explanation. It could be said that when a farm in the valley of the Mississippi or the Missouri produces with equal labor and capital twice as much as a similar farm east of the Hudson, and when it costs comparatively only a small fraction of the market price at Boston or New York to transport the Western product to those cities, the Eastern farmer must abandon the unequal struggle. But while the generally harsh and forbidding character of much of the New England soil is doubtless one of the reasons why most of its country towns have to-day less population than they had when the election of

Abraham Lincoln furnished the occasion for the long-contemplated secession of the cotton States; many of them less than when the embargo and the War of 1812 infuriated its Federalists almost to the point of armed resistance to the Washington government; and a few of them less than they had when the passage of the Stamp Act began the long struggle which was to terminate in the independence of America—it certainly is not the sole and is probably not the principal cause of this partial depopulation. The same thing is going on over extensive areas of the most fertile portions of the country. There are men still living who can remember when the "Genesee Country" filled the same place in popular imagination as a frontier wheat-producing district of marvelous fertility that is now occupied by the valley of the Red River of the North. Nor was it or is it only in one or a few great staples that the rich counties of central and western New York excelled. In all the products of the field, the orchard, the vineyard, the flock, and the dairy they occupied a high and in some the highest rank. Indeed, in the variety of its agricultural and pastoral productions New York is probably unsurpassed among the States, or surpassed by California alone. Yet with all these abounding resources for the support of a prosperous rural population, fifty of its fifty-five counties north of the Harlem have fewer inhabitants outside of their cities and towns than they had ten years ago. Of the five exceptions to the general rule of rural decrease, two, Westchester and Rockland, lie immediately north of New York city; two others, Franklin and Hamilton, include the most thinly settled portion of the Adirondack wilderness; and in the fifth, Schenectady, the increase during the decade has been just twelve, or at the rate of about one eighth of one per cent. The decrease of rural population has thus been as general in fertile New York as in sterile and rock-bound New England. The rural population of New York north of the Harlem in 1880 and 1890 compares as follows:

1880	1,894,795
1890	1,725,913
Decrease	168,882
Percentage of decrease	8·91

When the nineteenth century began, western New York was almost entirely destitute of white inhabitants. Yet so rapid are the movements of population in the United States—in which, what sixty years ago was a mere hamlet clustering around the frontier Fort Dearborn, is now a mighty municipality with a population larger than had any of the historic capitals of Europe a century ago—that most Americans would consider all the region from the Niagara to the Hudson as a portion of the older settled

sections of the country. In the decades immediately succeeding 1820 the New York canal system gave many portions of the State advantages not possessed in equal degree, if at all, by any other equally productive and extensive section of the then settled area of the land. The development of the railroad system of the country has made the canals of far less relative importance to-day than they were sixty years ago. The lessened value of its exceptional transportation facilities and its consequent nearness to the ocean and the world beyond, might be thought to explain the decrease of population of rural New York, were it not that regions which never enjoyed those facilities, which are a thousand miles from the Eastern seaboard, and which were not thoroughly settled until after the railroad system had reached a considerable stage of development, show a similar decrease. The nine southeastern counties of Minnesota cover an area of 5,682 square miles—that is, they are together about one sixth larger than Connecticut. Only forty years ago they were an unsettled wilderness, and yet every one of the nine has fewer rural inhabitants than it had ten years ago. Outside of the cities and towns these counties had, in 1880, 149,622 inhabitants, and in 1890 but 138,259, a decrease of 11,363, or at the rate of 7·60 per cent, a ratio of decrease but slightly less than in rural New York. This decrease becomes doubly significant in the light of the fact that a similar loss has taken place over a very wide area of which this corner of Minnesota forms only the northwestern extremity. From the time a traveler down the Mississippi leaves St. Paul until he reaches a point more than fifty miles south of St. Louis, or during the journey between places which are over five hundred miles from each other in an air line, and very much farther following the bends of the river, there will only be once, and that while traveling less than twenty miles, when either on one bank of the river or the other, and usually on both, he will not be passing counties which had less rural population according to the eleventh census than were credited to them by the tenth. The distance back from the river to which this area of decrease extends ranges at different points all the way from twenty miles or less to more than two hundred. If the counties which had less rural population in 1890 than in 1880 be distinctly colored upon a map, it will appear that the Mississippi, from the thirty-eighth to the forty-fifth parallel, is the center of a very large tract composed entirely of such counties. This tract, while very irregular in outline, is composed entirely of contiguous counties, as the word contiguous at all events is practically construed by the modern disciples of Elbridge Gerry. It extends over portions of the five States of Minnesota, Iowa, Missouri, Illinois, and Wisconsin. It has an area of 81,020 square miles, or nearly a third more than that of all the New Eng-

land States combined, and not ten per cent less than that of Great Britain. Of the 141 counties into which this tract is divided, no less than 138 have lost rural population since 1880; and the average increase in the three increasing counties, which form *enclaves* within it, has been less than three and three quarters per cent. The following is the result of a comparison of the rural population in 1880 and 1890 of the 141 counties as a whole:

Rural population 1880	2,582,620
Rural population 1890	2,402,876
Decrease	179,744

The percentage of decrease of rural population in this rich, fertile, and comparatively lately settled section of the country is 6·96, or about one fifth less than in New York. The decrease is especially general in the counties immediately bordering on the Mississippi River. For example, every Mississippi River county in Iowa has lost rural population. Of the sixteen counties on the west bank from Dakota County, Minnesota, to Clark County, Missouri, inclusive, there is not one which had more rural inhabitants in 1890 than in 1880; and of the seventeen on the east bank, lying between the northern boundary of Crawford County, Wisconsin, and the southern boundary of Randolph County, Illinois, there was but one. Speaking generally, southern and eastern Iowa lost rural population during the decade, while northern and western Iowa, still in 1880 comparatively thinly settled, have gained, and in some sections largely. In the State as a whole, however, there has been a decrease of such population in no less than forty-three out of its ninety-nine counties. Such a showing in a trans-Mississippi State not yet half a century in the Union is one well calculated to arrest attention.

Whether the prohibition laws, which have been in force during the greater part of the decade, have been unfavorable to the growth of this State or not, it is certain that their existence has not been the chief cause of the decrease just mentioned, for, if in prohibition Iowa 43 out of 99 counties have a diminished rural population, in Illinois, in which prohibition does not exist, the same fate has overtaken 60 out of its 102 counties, a still larger proportion of the whole. And Illinois is the principal farming State in the Union. Almost all the northwestern part of the last-named State has fewer rural inhabitants than in 1880. In some of its northern and central portions, the area in which there has been a decrease of rural population in the decade extends entirely across the State, from the Mississippi River to the Indiana border. If the southern boundary of Iroquois County, Illinois, lay five miles south, or the northern boundary of Warren County, Indiana, the same distance north of its actual position, the great

Mississippi area of decrease would form an unbroken continuation of a still larger contiguous territory of decreasing counties, extending from the eastern border of Illinois to Cape Cod, and from Alabama into the Maritime Provinces of the Canadian Dominion. The portion of this territory lying within the United States extends into fifteen States, covers an area of 174,500 square miles, or over a third more than that of the British Isles, and comprises 289 counties. Of these counties 276 have less rural population than they had in 1880. Of the thirteen increasing counties lying within the lines of this territory and surrounded by the decreasing counties, two are in the Adirondacks; eight of them comprise the suburbs of Cleveland, Cincinnati, Louisville, Indianapolis, Dayton, and Columbus; and in the remaining three the increase during the decade has been but thirty-two, or at the rate of less than one sixteenth of one per cent.

Taking the entire area together, the rural population in 1890 and 1880 compares as follows:

1880	6,542,070
1890	6,145,943
Decrease	396,127
Percentage of decrease	6·05

This tract, beginning in the province of New Brunswick, extends over all New England, except the northern portion of Maine and New Hampshire and the northeastern county of Vermont; over large portions of Ontario and Quebec; over all New York north of the counties of Rockland and Westchester; over northwestern New Jersey, and large areas of northeastern and northwestern and a small part of southwestern Pennsylvania; over the greater part of Ohio, except its northwestern and some of its eastern and southern counties; over a couple of West Virginia counties lying on the Ohio border; over all southeastern and much of central Indiana; over a number of the Ohio River counties of Kentucky, and thence over a long and in places comparatively narrow strip of central Kentucky and Tennessee into northern Alabama, in which State it includes four counties; finally coming to an end some thirty miles south of the Tennessee River. The New England States, with New York and the adjacent counties of Canada, form the compact portion of this tract. From the southern boundary of New York it stretches out in two arms, one to the east and the other to the west of the Alleghanies. The eastern arm is much the shorter of the two, and without a break reaches only to the southern boundary of Carbon County, Pennsylvania, on the one side, and to the Atlantic coast in Burlington County, New Jersey, on the other. The break here is, however, very short, it being not over five or six miles to the point at which

another area of counties with decreasing rural population begins and extends down over Berks and Chester Counties, Pennsylvania, Salem County, New Jersey, the two northernmost of the three Delaware counties, and the three most northerly of the counties of the Eastern Shore of Maryland, comprising in all eight counties and some four thousand square miles of territory. This southern extension of the region of decrease last mentioned, both in Pennsylvania and on the Eastern Shore of Maryland, very nearly approaches the northern prolongations of still another district in which the rural population was less in 1890 than in 1880. The principal portion of this district lies in Virginia, in which State it comprises forty-five counties. On the south it extends into one of the border counties of North Carolina, and on the north stretches over southern and western Maryland up into central Pennsylvania. It has an area of 24,092 square miles, divided among sixty counties, of which Henrico County, Virginia, containing the city of Richmond, is the only one which has not less rural population than it had ten years ago. In Virginia, with two exceptions, all the decreasing counties lie east of the summits of the Blue Ridge range, and these decreasing counties include nearly the entire Piedmont and midland section of the State. Some—but by no means all—of the tide-water counties lying on or near the Chesapeake Bay, owing probably to the growth of the oyster and trucking industries, have gained population. The rate of decrease in this group of decreasing counties has been somewhat less than in most of the others. The rural population in 1880 and 1890 of the area referred to compares as follows:

1880	949,679
1890	902,413
Decrease	47,266
Percentage of decrease	4·98

The last two groups are apparently detached extensions of the eastern arm of the great northeastern decreasing district. The western arm of this district has a general southwest and northeast direction, roughly parallel to the trend of the Appalachian system and to the west of it. As before stated, a western offshoot or projection from this arm crosses the entire State of Indiana, and comes within five miles or less of connecting it with the great area of decreasing counties which has the Mississippi River for its center. In northwestern Ohio and northern central Indiana there is a tract in which the population outside of the cities, towns, and villages has increased during the last ten years. Many if not most of these counties lie in the region in which natural gas has been so extensively made available during the last ten years; but whatever be the cause, the rural or extra-urban population of this

tract has increased, and it separates the great northeastern area of decreasing counties from a much smaller, but still an important and well-defined one, comprising twenty-five counties in southern Michigan, six in northern Indiana, and the northwesternmost county of Ohio. This tract, which therefore includes thirty-three counties in all, and covers an area of 18,373 square miles, or about equal to the combined area of Vermont and New Hampshire, is quite regular in its outline. It includes, with the exception of a couple of counties on the Lake Michigan shore, practically all the counties of the southern half of the lower peninsula. The counties in the immediate vicinity of Chicago, and which have gained, perhaps, as a result of the enormous growth of that city, separate this area of decrease central in southern Michigan from that of which the Mississippi River is the center.

The rural population of this area in Michigan, northern Indiana, and northwestern Ohio at the tenth and eleventh censuses compares as follows:

1880	775,053
1890	729,423
Decrease	45,630
Percentage of decrease	5·89

There are some clusters or groups of decreasing counties scattered over the cotton States. Thus, in northern Mississippi and southwestern Tennessee there is a group of some eight counties, each of which has lost rural population. This group is very nearly connected through northern Alabama with the great decreasing group of the Eastern and Central States. There is another group on the Mississippi and Big Black Rivers in Mississippi and Louisiana, several in central Georgia and Alabama, and a well-defined one in that part of Florida which adjoins southwestern Georgia. Compared, however, with the Northern and border States, the decrease in the far Southern States is by no means noteworthy.

There are in the far West counties which show the usual fluctuations of frontier communities, in which a too rapid boom is not infrequently followed by a period of depression in which emigrants are more numerous than immigrants. The decay of the mining industries of Nevada and the adjacent portions of California and Utah has caused a relatively very heavy decrease in the population of this region, a decrease which has been felt by the cities as well, though usually not to so great an extent as by the more isolated mining camps and the farming settlements dependent upon the mines for a market for their products. But with the exception of a few of the older counties of Kansas, in which the same influences have apparently been in operation as

in the Central and Eastern States, there has of course been in the trans-Missouri States no decrease of rural population in the proper sense of the term.

East of the Missouri and north of the cotton States, nearly all the well-settled agricultural neighborhoods have fewer inhabitants than they had ten years ago. It is possible to travel from the Bay of Fundy to the southern bend of the Tennessee River, a distance of fifteen hundred miles, and not pass through a single county in which the rural population is not less than it was ten years ago; or go all the way from Boston to western Iowa, except for the space of about five miles, through counties with less rural population than they had in 1880.

The better adapted for farming a community east of the Missouri may be, the greater the apparent probability that it lost rural population during the last ten years. As a rule, in the older States it was only the mountain sections, and other regions containing mineral wealth or resources other than purely agricultural ones, which showed a gain of extra-urban population. Districts situated near great cities, and well adapted for early vegetables and fruits, have in some instances gained, but, as a rule, communities which depend upon farming as distinguished from trucking have fewer inhabitants than they had in 1880.

In that great section of country comprising New England, New York, Pennsylvania, Delaware, Maryland, the District of Columbia, Virgina east of the Blue Ridge Mountains, Ohio, Indiana, Michigan south of the forty-third parallel, Illinois, Wisconsin south of the forty-fourth parallel, Iowa east of the ninety-fourth meridian, and the southeast corner of Minnesota, there are some 726 counties, and of these no less than 450 have lost population since the tenth census was taken. Each of the New England States, New York, Maryland, Ohio, and Illinois had fewer rural inhabitants than it had in 1880. Pennsylvania is the only one of the older Northern States to show any substantial increase of extra-urban population, the gain during the decade being at the rate of about 7·29 per cent. In this State the growth has doubtless been due to other causes than the increase of classes directly dependent upon agriculture.

The general tendency to a loss of rural population is manifest in regions which differ in the character of their soil as widely as does a rocky and sterile hill town in New England from a rich prairie county in Illinois or Iowa, and whose climatic conditions are as unlike as are those of the Mississippi in the latitude of St. Paul and of the James at Richmond, Virginia, or as those of Vermont and Alabama. In some of the districts in which the loss is marked, hay and rye are the staple crops, in others wheat, in others maize, and in others tobacco. In the decreasing dis-

tricts the average density of settlement, exclusive of the population of the cities and towns, varied in 1880 all the way from twenty-six to the square mile in Minnesota to nearly or quite sixty in New Jersey. The average density in the great Mississippi region of decrease was in 1880, 31 to the square mile, and in 1890, 29; in the Virginia group it was in 1880, 39, and in 1890, 37; in the Michigan group it was in 1880, 42, and in 1890, 39; and in the eastern group it was in 1880, 45, and in 1890, 42.

While probably every census has revealed more or less marked decreases in particular neighborhoods, at no previous census did so large a portion of the country show a loss of its rural population. Still, while the area over which the decrease extends is comparatively large, the tendency to a loss of rural population is by no means a new one. There are counties as far west as Illinois, which have been losing rural population for the last twenty years. As already stated, there are Massachusetts towns which have less population than they had at the close of the last great French War. There are Virginia counties which have fewer inhabitants than they had one hundred years ago. It is a curious circumstance that among these counties is Caroline, best known to persons who are not Virginians by its association with the name of the mover of the Resolutions of 1798. Colonel Taylor, who labored no less earnestly for the improvement of agriculture than for the maintenance of the strictest construction of the Constitution, seems by the result to have had even less success in the former than in the latter object of his desire. In the adjoining State of Maryland, the county of Charles, lying on the Potomac, a few miles below Mount Vernon, has to-day twenty-five per cent fewer inhabitants than it had when the proprietor of Mount Vernon was inaugurated first President of the United States.

While the country regions have been losing population or gaining it but slowly, the cities, towns, and villages have, as a rule, grown rapidly, except in Nevada. While individual cities have differed widely in their respective rates of increase, if the cities of the country be classified according to size, it will be found that large cities and small towns are alike growing rapidly, and that the difference in the rate of their growth is not very great. To this statement New England is an apparent though not a real exception. In the New England States the towns with between 1,000 and 2,000 inhabitants each in 1890, have actually lost population during the decade, while those with between 2,000 and 4,000 inhabitants have gained but little, and those with between 4,000 and 8,000 very much less than have places of a like grade in other portions of the country. The explanation, of course, is that, as before stated, these towns correspond to the townships and other local subdivisions in other States, and, as such, nearly all

of them contain more or less rural population, while many of the less populous are purely rural. An accurate idea of the relative rates of growth of the different grades of places can therefore be obtained only by excluding the cities and towns of the New England States from the comparison. In the following table, the cities, towns, and villages of the country are classified according to the number of their inhabitants in 1890; the number of each class in 1890 is given, together with the aggregate population in 1890 and 1880 of the cities which in 1890 were in each class, the increase during the decade, and the percentage of that increase. In the column to the extreme right is given the percentage of increase of each class of cities, exclusive of those in the New England States:

Cities having a Population in 1890 of—	No.	Population, 1890.	Population, 1880.	Increase.		
				Number.	Per cent.	Per cent exclusive of New England.
Over 1,000,000	3	3,662,115	2,556,654	1,105,461	43·24	43 24
From 500,000 to 1,000,000.	1	806,343	566,663	239,680	42·30	42·30
" 250,000 " 500,000.	7	2,447,608	1,850,048	597,560	32·30	34·42
" 125,000 " 250,000.	14	2,464,458	1,501,573	962,885	64·12	66·99
" 75,000 " 125,000.	14	1,229,600	818,180	411,420	50·28	53·91
" 40,000 " 75,000.	35	1,819,686	1,141,150	678,536	59·46	68·85
" 20,000 " 40,000.	92	2,506,279	1,598,844	907,435	56·76	62·06
" 12,000 " 20,000.	107	1,659,353	1,105,913	553,440	50·04	56·53
" 8,000 " 12,000.	175	1,721,894	1,072,375	649,519	60·57	67·65
" 4,000 " 8,000.	457	2,514,911	1,769,513	745,398	42·12	52·51
" 2,000 " 4,000.	1,011	2,794,409	1,938,184	856,225	44·18	55·14
" 1,000 " 2,000.	1,799	2,515,369	1,855,979	659,390	35·53	58·81
Total cities and villages.	3,715	26,142,025	17,775,076	8,366,949	47·07	53·73

From the above table it appears that, as a rule, the cities which now have a quarter of a million or more inhabitants have not increased during the decade as rapidly as those having a smaller population. The difference would have been even much more marked than it is, if it had not been for the wonderful growth of Chicago. The ten cities, outside of New England, with more than a quarter of a million inhabitants each, have gained at the rate of 40·28 per cent during the decade, while the rate of increase in the 2,881 cities, towns, and villages having in 1890 from 1,000 to 250,000 inhabitants each, averaged 60.19 per cent, or nearly one half greater. Among the various classes of cities included in these 2,881 places, there was during the decade no important difference in the rapidity of growth perceptible, although, on the whole, the places with from 20,000 to 250,000 grew slightly, but only slightly, more rapidly than those having less than 20,000. Although the smaller cities considered together have grown as rapidly as have the larger, the difference among the respective

rates of growth of the cities of the same class are likely to be greater in the smaller cities than in the larger. Among the smaller places, and especially among those with less than 4,000 inhabitants, instances of an actual decrease in population during the decade are not unusual. The contrary is true for the larger cities. During the decade, every one of the 101 cities which in 1880 had upward of 20,000 inhabitants, gained in population more or less rapidly. Of the 82 cities which in 1880 had between 12,000 and 20,000 inhabitants each, only three, and of the 110 having in 1880 from 8,000 to 12,000 inhabitants only six, have less population than they had ten years ago. But out of the 333 places which in 1880 had a population of from 4,000 to 8,000 each, no less than 40 suffered during the decade a net loss of inhabitants, and among the still smaller places the proportion of those whose population decreased was still greater. Taking all the cities together, however, their increase was so great and so general that only in the Dakotas, Idaho, Arizona, and Louisiana does the rural population constitute a larger percentage of the entire population than it did in 1880. In all but the last of these the total population in 1880 was very small, and during the decade the greater portion of the immigrants to them have not sought the cities.

For some reason the cities and towns of Louisiana have grown very slowly during the decade, but even in this State the proportion of urban to the total population has fallen but one tenth of one per cent.

Although four of the five States and Territories in which the urban population constituted in 1890 a less proportion of the aggregate number of inhabitants than in 1880 lie wholly or partially west of the Missouri, in some of the trans-Missouri States the growth of the cities has been phenomenally rapid. Thus, in Washington the urban population in 1880 was but 14,474, while in 1890 it was 152,033, or more than ten times as great. In 1880 Seattle, Tacoma, and Spokane Falls had but 4,981 inhabitants, and ten years later 98,765, or nearly twenty times as many. It is significant of the altered conditions of modern life that a larger proportion of the population of Washington—the serious settlement of which dates back but a little over forty years, which spreads over more than eight times the area of Massachusetts, and which is not yet a manufacturing State—resides in cities of over 8,000 inhabitants, than was the case in Massachusetts as late as 1840, nearly two centuries and a quarter after the Plymouth landing, and when it had long been the principal manufacturing State in the Union.

In the three Pacific States as a whole very nearly one half of the entire population reside in cities, the urban population num-

bering 901,644, as against a rural population of 969,643. In this, as in some other respects, the conditions of life in California suggest resemblances to those existing in the Australian colonies. Australia, together with New Zealand and Tasmania, had in 1891 a population slightly less than that of the United States in 1790. This population is scattered over an area several times more extensive than was that of this country before Napoleon sold us Louisiana; and yet in Australia a larger proportion of the entire population resides in cities of 8,000 inhabitants or upward than is the case in the United States even to-day.

The ratio of urban to rural population is increasing rapidly over almost all the civilized world. In many countries large areas have recently experienced an absolute loss of rural inhabitants. The census of 1891 shows that the population of the urban sanitary districts of England increased since 1881 about fifteen per cent, as against an increase in the rural districts of less than four per cent. Some of the more purely rural counties of England show an actual decrease of aggregate population, as do no less than nine of the twelve counties of Wales and sixteen out of the thirty-three counties of Scotland. In the last-mentioned country the rural population of the entire kingdom is a fraction less than it was ten years ago. In Ireland the contrast is still greater. Out of its thirty-two counties there are only two which have not less population than in 1881. These two are Dublin and Antrim, containing the cities of Dublin and Belfast respectively. The sixteen Irish cities and towns with 10,000 inhabitants or over have increased on the average at the rate of something over six per cent, while the rest of the country has suffered a loss of nearly twelve per cent. In France the increase of total population in the five years from 1886 to 1891 was but 124,289, while the gain in the population of the fifty-six cities having over 30,000 inhabitants was 340,396. Outside of these cities there was an actual decrease of 216,107. In Germany two thirds of the total increase of population between 1885 and 1890 was in the 150 places having over 20,000 inhabitants each, although these places contain not more than one fifth of the entire population of the empire.

Something over a century ago Jefferson, in his Notes on Virginia, arguing against the establishment of manufactures in this country, declared that, "generally speaking, the proportion which the aggregate of the other classes of citizens bears in any State to that of its husbandmen is the proportion of its unsound to its healthy parts, and is a good enough barometer whereby to measure its degree of corruption." Popular feeling almost everywhere seems to view with something of Jefferson's apprehension that change in the proportion of urban to rural population now so

rapidly going on. In almost all countries those who desire to change existing systems of taxation try to enlist in their behalf this popular feeling by ascribing the decline of rural population to the operation of the fiscal machinery they dislike. Thus, in free-trade England, "fair-traders" assert that some scheme of retaliatory duties is required to arrest the depopulation of the rural districts. In France an extremely protective tariff has recently been adopted, largely at the demand of the agricultural classes. In the United States, on the other hand, those who are opposed to protective taxes are equally positive in their assertions that such taxes are the principal cause of the decrease of population in so many fertile sections. Doubtless, like other local conditions, tariff changes may help or hinder the operation of the general causes which are at work the world over. Those causes, however, were not set in motion by legislation, and could not be permanently checked by it, unless it should take so drastic a form as to be fatal to the material welfare of the whole community.

That the urban shall grow more rapidly than the rural population is, under present conditions, an economic necessity. The generally low prices of agricultural products during the last few years unite with most other available data to show that the supply of such products is increasing at least as fast as and probably faster than the increase in aggregate population. In this country, although the census of 1890 showed an increase of but twelve per cent in the rural population, and of less than twenty-five per cent in the aggregate population, the average production of wheat for the decade preceding the census of 1890 was forty-four per cent greater than that for the decade preceding the census of 1880; that of corn forty-three per cent greater, and of oats eighty-five per cent greater. In the cotton belt, the only agricultural portion of the older States in which there has been any considerable increase of rural population, we see in the great overproduction of cotton for several years in succession what would necessarily happen in other staple products if as large a proportion of the population as formerly attempted to earn their living by tilling the soil.

In a neighborhood in which all the tillable land was taken up thirty years or more ago, as is the case in all or nearly all the counties of the older States in which the rural population has diminished, there are general causes at work to bring about the result. The constant and steady improvement in agricultural machinery enables fewer hands than were required thirty years ago to cultivate the land with equal efficiency. To employ the same number of men as formerly, closer cultivation would be necessary. Perhaps, because such closer cultivation will not pay when its products have to be sold in competition with the more easily raised crops of the trans-Mississippi or trans-Missouri

States, or perhaps because the conservatism which is so marked a trait of agricultural populations makes it exceedingly difficult to bring about any radical change in agricultural methods, higher farming has not made much progress. It must also be remembered that both in Europe and the United States the birth-rate is diminishing. One of the results of this diminution is that the children constitute a smaller proportion of the entire population than formerly, and consequently a total population of the same aggregate number contains more workers.

Another cause of decrease in the aggregate population of rural communities, and one perhaps as potent as either of those already mentioned, is the ever-increasing competition of factory-made goods with the products of the handicrafts. There must be fewer and fewer country tailors, shoemakers, blacksmiths, carpenters, and other artisans who can earn their living in competition with the machine-made goods which the steadily decreasing cost of railroad transportation enables the great factories in the manufacturing cities and towns to send into every neighborhood and sell more cheaply than the isolated mechanic working with his own hands or with simple and inexpensive machinery possibly can. Those who are forced to give up the attempt to earn their bread by working at their trade in their old homes among their neighbors must seek employment in the cities. The whole tendency of the factory system, combined with the cheapening of transportation rates, is to draw away from the country districts almost all the population not directly engaged in tilling the soil. The social and intellectual attractions of city life, especially for the brighter and more active-minded of the country youth, are unquestionably powerful factors in building up the cities at the expense of the country districts. The two last-named causes—namely, the diminution of the number of rural handicraftsmen in all localities easily accessible by railroad from large cities, and the attractiveness of city life to portions of the country population, when city life is brought within the range of their observation—are doubtless chiefly responsible for the fact that the decrease of the rural population has been most general in precisely those portions of the country in which cities and towns are most numerous and in which the railroad facilities are the best.

In this country it is possible that the actual decrease in rural population during the decade was not so great as the census would indicate. To properly fill up the schedules of the eleventh census required so much work upon the part of the enumerators that the fees allowed them in country districts were in many, if not in most cases, utterly inadequate to give them a reasonable compensation for their work. Baltimore County, Maryland, is a very thickly settled agricultural region, and yet in this county a number of in-

telligent and industrious enumerators working from ten to twelve hours a day were not able to average a daily wage of more than two dollars each, out of which they had to provide a team and to pay its expenses and their own while away from their homes. Under such conditions it is not impossible that some of the less conscientious enumerators may have slighted remote corners of their districts. As the complaint of the inadequacy of the pay was quite general, and entirely justifiable, it is possible that there were considerable omissions in many rural neighborhoods.

AN AGRICULTURAL REVOLUTION.

By Prof. CLARENCE M. WEED.

DURING the last half-century the agriculturists of the United States have constantly suffered from the attacks of two classes of organisms, which have disputed with them the possession of their crops. These organisms are, first, the noxious insects; and, second, the parasitic fungi. To these tiny foes American agriculture yields annually many million dollars' worth of her choicest products. They form an omnipresent host of tax-gatherers, taking possession of the farmer's crops and enforcing their onerous demands without process of law, unless preventive measures are vigorously prosecuted. They are no respecters of persons: like the rain, they fall upon the fields of both the just and the unjust.

The authorities best able to judge have estimated the annual loss in the United States due to these little pests at more than half a billion dollars. Noxious insects, according to Dr. C. V. Riley, the distinguished entomologist of our National Department of Agriculture, occasion losses in the United States which are "in the aggregate enormous, and have been variously estimated at from $300,000,000 to $400,000,000 annually," and parasitic fungi —the rusts, smuts, blights, mildews, rots, and similar maladies of growing plants—according to competent authorities, cause an equal or greater loss. In single States and single seasons the damage is often frightful in extent. During some of the great chinch-bug epidemics the loss in Illinois occasioned by this one insect has amounted to over $73,000,000 a year; and in seasons not marked by an outbreak of such a great crop pest the injury is much more severe than is ordinarily supposed. The official entomologist of the State just named, Prof. S. A. Forbes—after years of careful field observation and statistical study—has recently expressed his belief that "the insects of the State of Illinois derive

as large a profit from the agriculture of this great agricultural State as do the farmers themselves."

Fortunately, however, much progress has recently been made in a knowledge of efficient means of preventing this vast drain upon our productive system. By the introduction of a simple mechanical contrivance for the application of insecticides and fungicides, the methods of combating these foes have been revolutionized; and in many localities where the production of special crops had been abandoned new life has been put into their development. This contrivance is commonly called the spraying machine. It consists essentially of a force pump and spray nozzle connected with a reservoir, by means of which certain substances that have a destructive effect upon insect and fungous life may be rapidly and evenly distributed over the outer surfaces of trees, shrubs, vines, and herbaceous plants.

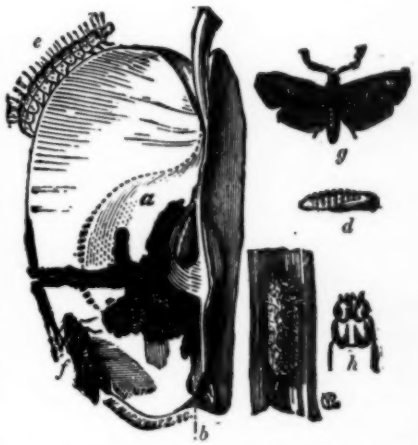


FIG. 1.—CODLING MOTH: *a*, injured apple; *b*, place where egg is laid; *e*, larva; *d*, pupa; *i*, cocoon; *g*, *f*, moth; *h*, head of larva. (After Riley.)

In America the spraying machine seems to have first come into general use to prevent the injuries of the codling moth or apple worm. This is a very destructive and widely distributed insect, for which there had before been known no remedy that can compare with spraying in cheapness and efficiency. These worms hatch from eggs laid in the calyx ends of the newly formed apples by a small, chocolate-colored moth (represented at *f* and *g*, Fig. 1). These eggs are deposited in spring or early summer, from the time the young apples are as large as peas until they attain the size of small hickory nuts. The eggs are placed on the outside of the fruit, and the resulting worms nibble at the skin, finally biting through and eating toward the core. They continue feeding for three or four weeks, when they become three fourths of an inch long, whitish or pinkish-white in color, and of the general form shown in Fig. 1, *e*. They are now full grown as larvæ, and leave the apples to spin, in some temporary shelter, slight silken cocoons (*i*), in which they transform to pupæ (*d*), to change a fortnight later into full-fledged moths. These moths deposit eggs about midsummer for a second brood of worms.

The earlier preventives of codling-moth injury included such partially effective measures as banding the trees with wisps of

hay or loose cloth, to entice the larvæ to spin their cocoons in them, and the feeding of fallen fruit to stock. A serious objection to these methods lay in the fact that the worms were only destroyed *after* they had done their injury. But now, thanks to the spraying machine, the fruit-grower can place in the calyx ends of the young apples a few particles of poison, which as a rule will kill the newly hatched worms before they enter the fruit. For this purpose three or four ounces of London purple or Paris green are thoroughly mixed with a barrel of water. The apple trees are sprayed with this mixture just after the blossom petals have fallen off. The poison particles are thus distributed over the tree in a fine mist, and when the water in which they are suspended (not dissolved) evaporates, they are left high and dry upon the leaves and fruit, there to remain a menace to insect enemies for several weeks. In the course of time the combined action of rain

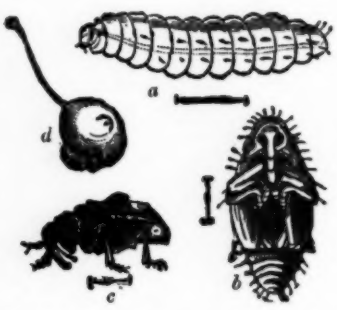


FIG. 2.—PLUM CURCULIO: *a*, larva; *b*, pupa; *c*, beetle—magnified; *d*, plum showing crescent mark. (After Riley.)

FIG. 3.—APPLE INJURED BY CURCULIO.

and dew, wind and sunshine dissipate their poisonous properties. By thus destroying the first brood of worms one is saved the trouble of fighting the second brood.

For many years it has been very difficult to produce plums and other stone fruits on account of the injuries of the plum curculio. The adult of this species is a small, hard-shelled beetle (Fig. 2, *c*), which appears in the orchard early in spring, and feeds upon the foliage and flowers until the fruit is well formed. It then attacks the young plums, gnawing at them to satisfy its hunger, and cutting crescent-shaped holes (*d*) in the skin for purposes of oviposition. The eggs hatch into minute grubs that feed upon the pulp for a few weeks, ruining the plums and causing them to fall to the ground. The grubs (*a*) then leave the fallen fruit, enter the soil a short distance, change to pupæ, and later again change to adult beetles. There is but one brood each season, the insects wintering over mostly as beetles.

Besides stone fruits this insect attacks apples and pears, caus-

ing a dwarfing and malformation that are very vexatious to the horticulturist. An apple thus damaged is shown in Fig. 3.

The eggs of the curculio are deposited beneath the skin of the fruit, and the larvæ remain concealed until full-grown. Consequently the early stages of the insect can not be reached by spraying. Fortunately, however, the parent beetles can be killed before many eggs are deposited, by sparsely coating the foliage and fruit with poison from the spraying machine, and thus the plums will be saved. The practicability of this has been proved repeatedly by commercial orchardists.

In addition to the insects affecting orchard fruits, there are hosts of enemies to the foliage. Nearly all of the latter, fortunately, are also open to destruction by means of the spraying machine. The canker worm is one of the most destructive of these foliage pests; at occasional intervals during the last century it has denuded thousands of orchard and shade trees in many parts of Canada and the United States. Its different stages are shown in Fig. 4. The damage is done by the worms or larvæ which hatch from masses of small cylindrical eggs (*e*), usually deposited upon the bark of the trees. These larvæ feed upon the parenchyma of the leaves, and sometimes cause a badly infested orchard to appear brown and seared, as if scorched by fire. They continue feeding for several weeks before becoming full-grown. Then they descend to the ground, burrow into the soil a short distance, and spin silken cocoons within which they change to the pupa or chrysalis state, remaining in this condition a few weeks, when the moths come forth. The two sexes of these moths differ greatly: the male (*a*) has large, well-developed wings, while the female (*b*) is wingless. The latter is of an ash-gray color. On emerging from the chrysalis she crawls to the base of the tree and ascends the trunk some distance; here the male finds her, and, after mating, she deposits her eggs on the twigs or branches of the tree.

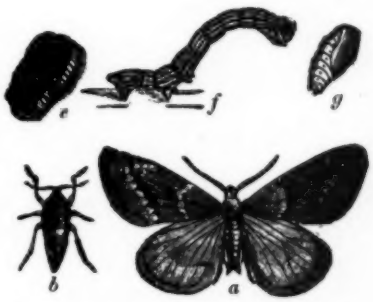


FIG. 4.—CANKER WORM: *e*, eggs; *f*, larva; *g*, pupa; *a*, male moth; *b*, female moth. (After Riley.)

The canker worm, like nearly all similar leaf-eating caterpillars, is so easily destroyed by spraying that, while in years past it was greatly dreaded by orchardists, it now inspires little fear.

The three insects above mentioned are all examples of those species having biting mouth-parts, and which in consequence attack the plant by biting piece by piece the tissues of leaf, stem, or fruit. It is on this account that they are open to destruction

by placing particles of poison upon the surface of the food-plant. A large proportion of our injurious insects have such biting mouth-parts, but there is also an important class which have, instead of jaws, a pointed beak that they push into the cells of the plant and suck out the sap. Insects of this kind can not be destroyed by coating the food-plant with particles of poison, because the particles will not be taken into the alimentary system. Consequently one must use against them some insecticide which kills by contact. There are several such insecticides in common use, the most important perhaps being an emulsion of kerosene, soap, and water, called the kerosene emulsion. It is usually prepared by adding two parts of kerosene to one part of a solution made by dissolving half a pound of hard soap in a gallon of boiling water, and churning the mixture through a force pump until the whole forms a creamy mass, which will thicken into a jelly-like substance on cooling. The emulsion thus made is diluted before using with nine parts of cold water, and is then sprayed directly upon the offending insects, killing them by simple contact. Among the more important pests against which this insecticide is used, I may mention the aphides or plant lice, the chinch-bug, the various cabbage worms, the lice of domestic animals, etc.

These examples will perhaps suffice to illustrate how valuable an adjunct the spraying machine has become in preventing the injuries of the hordes of destructive insects that overrun our farms, orchards, and gardens. Turning now to the other class of noxious organisms—the parasitic fungi—we shall find that it plays an equally important *rôle* in their subjection.

As the first illustration under this heading we will take the downy mildew or brown rot of the grape, a disease which for many years has troubled the vineyardists of the Eastern half of the United States, and has proved especially destructive in the great fruit belt of northern Ohio, along the southern shore of Lake Erie. It has often destroyed nearly the entire crop, and several times has threatened to ruin the vineyard industry over a wide area. Fortunately, however, this disaster has been averted by the timely introduction of the spraying machine.

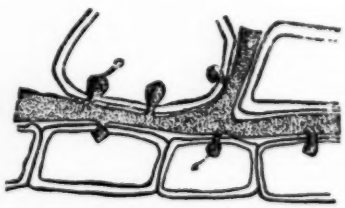


FIG. 5.—SECTION OF LEAF SHOWING MYCELIUM OF FUNGUS. Magnified. (After Farlow.)

The brown rot of grapes is a diseased condition of the fruit caused by the presence of a minute parasitic plant—a fungus—that develops by absorbing the tissues of its host. It attacks not only the fruit but also the leaves and young shoots, on which it often appears as a whitish, mildew-like covering, which has given

the disease its other common name of downy mildew. This fungus reproduces by means of minute particles called spores, corresponding in function to the seeds of higher plants. If one of these spores lights upon a moist leaf, its inner contents divide into a number of distinct particles, which soon escape through an opening in the spore wall; then each particle swims about in the film of water for a short time—resembling a little animal—when it becomes quiet and sends out a minute tube which penetrates the skin of the leaf. It then continues to develop inside the leaf, pushing about between the cells, and forming the mycelium or vegetative portion of the fungus. As there is little nourishment to be found between the cells, this mycelium develops minute processes, which push through the cell walls and absorb the cell contents. A small section of an affected leaf, greatly magnified, is represented at Fig. 5, the unshaded double-walled spaces showing the leaf cells, the shaded part between the walls the mycelium of the fungus, and the projections *a*, *a*, the processes or suckers that penetrate the cells. When these vegetative portions of the fungus have developed in the leaf to a certain extent, they send out through the breathing pores or stomata their fruiting branches, which bear upon their tips the small oval spores (Fig. 6). These fruiting branches form the so-called mildew on the plant, and, as they only appear under certain atmospheric conditions, the mycelium may exist in the vine for some time before this outward manifestation of its presence is seen. On this account a whole vineyard sometimes appears to be invaded by the mildew in a single night.

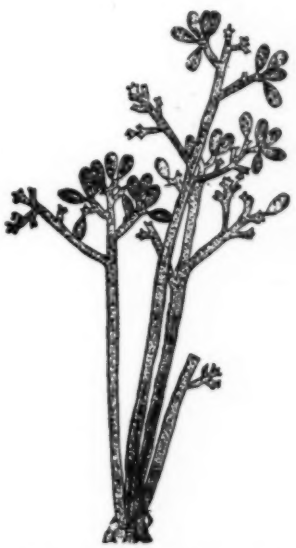


FIG. 6.—FRUITING BRANCHES. Greatly magnified.

From the above description it will be readily seen that this fungus can not be successfully combated after it has established itself within the tissues of the host. To prevent its injuries one must also prevent its ingress to the plant. Fortunately, this can be done by coating the green parts of the vine with some substance having a destructive effect upon the spores of fungi. The salts of copper have such an effect, and in consequence they have come into general use as fungicides. They were first experimented with on a large scale in the vineyards of France, and gave such satisfactory results that they were adopted in a practical way by many growers. In America this use for them has hardly been

known for more than a decade; yet, thanks to the remarkable series of investigations and experiments carried on by the Division of Vegetable Pathology of the Department of Agriculture—at first under the direction of Prof. F. Lamson-Scribner, and later that of Mr. B. T. Galloway—assisted to a considerable extent by several of the State experiment stations, their efficacy is already well attested, and they are in practical use over a large territory. The fungicides most commonly employed are the Bordeaux mixture, a combination of copper sulphate, lime, and water; *eau céleste*, a combination of copper sulphate, ammonia, and water; and various solutions of carbonate of copper. These fungicides are sprayed upon the plant early in the season, before the ingress of the disease-producing fungus, in such a way that after the water evaporates the leaves and stems will be coated with minute particles, usually crystals, of a salt of copper. These tiny sentinels stand guard over the plant; when a fungus spore falls upon the leaf and sends out its germinating tube, the latter comes in contact with the copper crystal and is destroyed.

The fungicide generally used for the downy mildew of grapes is *eau céleste*. It is first applied in spring, a few days before the vines blossom. One or two, and rarely three, additional applications are afterward made at intervals of about two weeks. In 1890 I made a special investigation of the results of spraying against this disease in northern Ohio, visiting many of the vineyards personally and sending out numerous letters of inquiry. As a result I was able to publish in the Bulletin of the Ohio Experiment Station (Vol. III, page 262) the following paragraph:

"The early part of the season of 1890 was peculiarly favorable to the development of downy mildew, and consequently an excellent opportunity was offered to test the value of *eau céleste* as a preventive. It has stood the test in a remarkable manner, and the efficiency of the preventive, when properly applied, has been proved beyond question. All accounts agree in this respect, and show that while the crops on the unsprayed vineyards averaged from one half a ton to a ton per acre, the sprayed vineyards yielded two to three tons per acre. Such results need no comment: they speak for themselves."

For many years pear trees, both in the nursery and orchard, have been seriously affected by a fungous disease that causes the leaves to drop during the summer prematurely, sometimes as early as June or July. It also often develops upon the young pears, causing a spotting and cracking of the fruit. The mycelium of this fungus grows between and through the cells of the pear leaf, causing circular brown spots to appear upon the surface; these spots gradually enlarge as the mycelium spreads through the tissues, and, finally, the whole surface being affected, the leaf

withers and falls off. By means of fungicides and the spraying machine, horticulturists are now able to prevent this disease completely. A large number of experiments in controlling it have been remarkably successful, and the difference between sprayed and unsprayed trees has been graphically illustrated by Mr. Galloway at Fig. 7, the engravings being faithful reproductions of photographs from Nature. Recent experiments have proved that the so-called apple scab—a disease which ruins a large percentage of the apple crop every year—may also be prevented by spraying

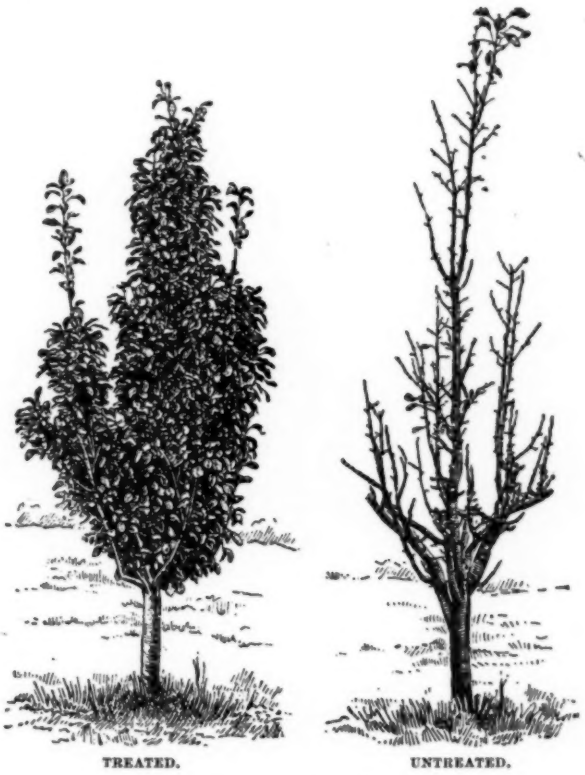


FIG. 7.—PEAR LEAF-BLIGHT EXPERIMENT.

with fungicides; and many other of the most destructive plant diseases are already under control, while experiments and investigations are continually progressing, with a view of bringing into subjection those which are yet out of reach.

It was naturally to be expected that the fruit-consuming public would object at first to purchasing fruit which they knew had been sprayed with poison. This is shown in the recent "grape scare" in New York city, and the present attitude of certain English journals toward the importation of American apples. But when the spraying, with either the insecticides or fungicides now

FIG. 8.—METHOD OF SPRAYING ORCHARDS WITH DOUBLE-ACTING PUMP AND VERMOREL NOZZLES. From Annual Report of Connecticut Agricultural Experiment Station for 1890.

commonly in use, is done with proper reference to the time, methods, and conditions of treatment, there is no danger to the consumer. Both practical experience and chemical tests have repeatedly shown that apples sprayed early in the season with Paris green or London purple retain none of the poison at the time of ripening. The most recent demonstration of this appears in the last report of the experimental farms of Canada. A peck of Rhode Island greening apples that had been sprayed twice with Paris green (one pound to two hundred gallons of water) were carefully gathered, without rubbing, and tested for arsenic. "The process to which they were submitted is one that affords extremely accurate results, and is considered the most delicate of all for the detection of arsenic. It is capable of revealing the presence of one fifty-thousandth part of a grain of arsenic. If twenty-three thousand bushels of apples contained two and a half grains of arsenic, the minimum fatal dose for an adult, the poison could have been detected by this method." Notwithstanding the most careful analysis no traces of poison were found; and, in conclusion, the chemist states: "I am of the opinion that further experiments of this nature would only serve to corroborate this negative result, and to prove that there are no grounds on which to base a suspicion that our sprayed apples are poisonous. The insoluble character of this poison precluding its assimilation by the apple, if such were possible, the infinitesimal part of Paris green that can remain on the apple, the frequent rains subsequent to the spraying, . . . all go to substantiate the argument that there is not the slightest danger of poisoning in using sprayed apples."

There is abundant evidence of a similar nature concerning the use of copper salts on grapes. In France, where a large proportion of the grape crop is converted into wine, elaborate investigations have shown that practically none of the copper salts are present in wine from sprayed vineyards. Prof. B. Fallot, of the School of Agriculture at Montpellier, in recording the results of one of these investigations, says: "The figures obtained have proved once more that wines, after the grapes have received numerous treatments with large quantities of salts of copper, contain scarcely a trace of this substance, and are entirely harmless."

Such is a meager and imperfect outline of this most recent improvement in the art of agriculture, which I have ventured to call an agricultural revolution. This improvement has been brought about by the combined efforts of the entomologist, the botanist, the chemist, the mechanician, and the agriculturist. Every step forward has been the result of careful study and experiment, and the whole subject is a striking illustration of the practical benefit agriculture may derive from scientific investigation and systematic experimentation.

GHOST WORSHIP AND TREE WORSHIP.

By GRANT ALLEN.

II.

PROVIDED with this universal master-key, then, we can now proceed to unlock many intricate puzzles of tree and plant worship which have hitherto baffled us. How full of meaning from our present standpoint, for example, is Mr. Turner's statement that at a certain spot in the island of Savaii there was "an old tree inland of the village, which was a place of refuge for murderers and other capital offenders! If that tree was reached by the criminal he was safe, and the avenger of blood could pursue no farther, but wait investigation and trial. It is said that the king of a division of Upolu, called Atua, once lived at that spot. After he died, the house fell into decay; but the tree was fixed on as representing the departed king, and out of respect for his memory it was made the substitute of a living and royal protector."* Not less striking is the case of the large tree, *Hernandia peltata*, in which "a family god of the same name" (as the native one of the tree) "was supposed to live; and hence no one dared to pluck a leaf or break a branch." In all these relatively primitive cases it is noticeable that it is a *family god* who is believed to inhabit the tree. We stand as yet quite close to the original form of worship which is almost exclusively domestic and directed straight at the heads of the family ghosts. After all this, it is interesting to read that on the closely related Savage Island the kings—who would of course be the descendants of such divine ancestors, and therefore themselves both gods and priests—"were supposed to cause the food to grow"; and that "the people got angry with them in times of scarcity, and killed them; and, as one after another was killed, the end of it was that no one wished to be king."† Readers of The Golden Bough, however, will be more likely to suspect that the kings were sacrificed on the same principle as the Rex Nemorensis, and that at last the royal stock got exhausted by too rapid using up of the whole available supply of divinity. Indeed, the proper keeping up of the king-god's family, in cases where godship has to pay for its dignity by the unpleasant incident of final sacrifice, willing or unwilling, must be an endless source of anxiety and trouble to primitive politicians. Where the safety of the crops and of the tribesmen themselves depends entirely upon a single life, a very painful state of tension must often exist, and the authorities must frequently

* Turner, Samoa, p. 65.

† Ibid., p. 305.

feel the strain imposed upon their consciences harder than they can bear.

One of the most striking pieces of evidence I have been able to obtain, however, is that of the Tanese in the New Hebrides, who, says Mr. Turner, in a passage I have already partly quoted, "have no idols. The banyan tree forms their sacred grove or temple for religious worship. . . . The spirits of their departed ancestors were among their gods. Chiefs who reached an advanced age were after death deified, addressed by name, and prayed to on various occasions. They were supposed especially to preside over the growth of the yams and the different fruit trees. The first fruits were presented to them, and in doing this they laid a little of the fruit on some stone" (query, a gravestone?) "or shelving branch of the tree, or some more temporary altar of a few rough sticks from the bush, lashed together with strips of bark, in the form of a table with its four feet stuck in the ground. All being quiet, the chief acted as high priest and prayed aloud thus: 'Compassionate father, here is some food for you; eat it; be kind to us on account of it.' And instead of an amen, all united in a loud shout."*

In Fiji, once more, the first fruits of the yam harvest are presented to the ancestors in the Nanga or sacred stone inclosure; and no man may taste of the new crop till the presentation has been made, a trait found also among other savages. The yams thus offered are piled up in the inclosure, and no one is allowed to touch them under pain of severe ghostly punishment. A mission teacher told Mr. Fison that when he visited the spot he saw among the weeds that grew there numerous yam vines which had sprung from the piles of decayed offerings—a most suggestive fact in the light of the origin I conjecturally assign to cultivation.†

In all these cases, and many others that might be quoted, it is to ancestral spirits as such that the offering is made. But often our authorities mention gods rather than ghosts, though the distinction between the two is probably but a small one. Among the Basutos, for instance, when the corn has been thrashed, it is left in a heap on the thrashing-floor, and can not be touched till a religious ceremony has been performed to sain it. The owners bring a new vessel, never used, to the spot, in which they boil a little of the corn as a sacrificial duty. Then they throw a few handfuls on the heap, saying: "Thank you, gods; give us bread to-morrow also." When this has been done, the rest may safely be eaten.‡ Many other cases are recorded by Mr. Frazer in the appendix to The Golden Bough.

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* *Op. cit.*, p. 319.

† Rev. L. Fison in Journal of the Anthropological Institute, vol. xiv, p. 27

‡ Casalis, The Basutos, p. 252.

But if any doubt exists that these gifts are in every case thank-offerings to the ghosts or ancestors who caused the crops to grow, it will be removed by the consideration that often the first fruits are offered not to spirits or gods at all, but to the divine king himself, who is the living representative and earthly counterpart of his deified ancestors.

In Ashantee a harvest festival is held in September, when the yams are ripe. During the festival the king eats the new yams, but none of the people may eat them till the close of the festival, which lasts a fortnight. During its continuance the grossest liberty prevails; theft, intrigue, and assault go unpunished, and each sex abandons itself to its passions. The Hovas of Madagascar present the first sheaves of the new grain to the sovereign. The sheaves are carried in procession to the palace from time to time as the grain ripens. So in Burma, when the *pangati* fruits ripen, some of them used to be taken to the king's palace that he might eat of them: no one might partake of them before the king.*

These cases, with many others of like sort which I forbear to quote, strikingly display the exact equivalence of the king, the ghost, and the god in the savage mind; for we find what is offered here to the living chief is offered there to his dead predecessor, and yonder, again, to the great deity who has grown slowly out of him. The god is the dead king; the king is the living god, and the descendant of gods, his deified ancestors.

Almost equally to the point is a statement of Mr. Macdonald's about the Blantyre negroes. "When there is no rain at the proper season," he says, "there ensues much distress. Famine is dreaded above all other evils. After private offerings have all failed, the chief of the country calls a national meeting for supplication. Much beer is brewed and offered to the spirit. The chief addresses his own god; he calls on him to look at the sad state of matters for himself, and think on the evils that are impending. He requests him to hold a meeting with all the other gods that have an interest or influence in the matter. . . . After the supplication there is a great dance in honor of the god. The people throw up water toward the heavens as a sign that it is water that is prayed for." [Say rather, as a sympathetic charm to make the rain follow.] "They also smear their bodies with mud or charcoal to show that they want washing. If rain do not come, they must wash themselves in the rivers or streams. If rain fall, they are soon washed in answer to their prayers. When the good crops follow, they present as a thanksgiving some the first heads of maize and some pumpkins." †

* The Golden Bough, vol. ii, p. 374.

† Africana, vol. i, p. 89.

This striking passage, remarkable enough in itself, becomes all the more important when we remember who are the gods to whom such prayers are offered and such thanksgivings due. They are, as Mr. Macdonald himself informs us, the deified relatives of the chief. "The chief of a village," says this acute observer, "has another title to the priesthood. It is his relatives that are the village gods. Every one that lives in the village recognizes these gods; but if any one remove to a new village, he changes his gods. He recognizes now the gods of his new chief. One wishing to pray to the god (or gods) of any village, naturally desires to have his prayers presented through the village chief, because the latter is nearly related to the village god, and may be expected to be better listened to than a stranger." *

Almost equally explicit as to the true nature of primitive ghosts and primitive tree worship is Sir William Hunter. "A Bengal village," he says, "has usually its local god, which it adores either in the form of a rude unhewn stone or a stump, or a tree marked with red lead." [Probably a substitute for the blood of human victims with which it was once watered.] "Sometimes a lump of clay placed under a tree does duty for a deity; and the attendant priest, when there is one, generally belongs to one of the half-Hinduized low castes. The rude stone represents the non-Aryan fetich; and the tree seems to owe its sanctity to the non-Aryan belief that it forms the abode of the ghosts or gods of the village." †

Omitting the mere guess-work about the fetich (whatever that may mean), and the gratuitous supposition, hazarded out of deference to the dying or defunct creed of Max-Müllerism, that ancestor worship must necessarily be a "non-Aryan" feature, this lucid account shows us the cult of the sacred tree in a very simple and early form as mere ordinary worship of the ancestral ghosts in the place where they are believed to make their home, without complications of any sort.

From these *naïve* and primitive types of sacred tree to the dark groves of cedar or cypress that surrounded the fetich-stone shrines of civilized Hellas is not surely a very far cry. We are already well on the track of the groves of Artemis, well within sight of the "opaca silvis redimita loca deæ," where Phrygian votaries worshiped with awful rites the mysterious goddess who rules over Dindima's height. Existing savages or low-caste Orientals thus give us the keynote that enables us to understand these dark places of antique usage and antique superstition.

Even in the midst of our own struggling civilization we shall not look in vain for obvious traces of this earliest and crudest

* Africana, vol. i, p. 64. † Imperial Gazetteer of India, article "India," s. v. "Religion."

form of tree worship, where the ghost itself is actually supposed to inhabit the branches of the sacred pine or the ancestral poplar. "The peasant folk lore of Europe," says Mr. Tylor, "still knows of willows that bleed and weep and speak when hewn; of the fairy maiden that sits within the fir tree; of that old tree in Rugaard forest that must not be felled, for an elf dwells within; of that old tree on the Heinzenberg near Zell, which uttered its complaint when the woodman cut it down, for in it was Our Lady, whose chapel now stands upon the spot. One may still look on where Franconian damsels go to a tree on St. Thomas's day, knock thrice solemnly, and listen for the indwelling spirit to give answer by raps from within what manner of husbands they are to have."* These cases fall at once into place if we recollect that elves and fairies are mere minor varieties of ancestral spirits, and that Our Lady often replaces for modern votaries the older and pre-Christian divinities of very ancient origin.

Other instances collected by Mr. Tylor are hardly less obviously explicable on similar principles. Here are a few select cases from savage peoples. The North American Indians of the far West will often hang offerings on trees, "to propitiate the spirits." Darwin, in the Voyage of the Beagle, describes the loud shouts with which the Indians of South America will often greet some sacred tree, standing solitary on some high part of the Pampas, a landmark visible from afar, and therefore, one might almost be inclined to guess from analogy, occupying the summit of some antique barrow.† Libations of spirits and maté were poured into a hole at its foot to gratify the soul of the indwelling deity. So, too, the New-Zealanders hang an offering of food on a branch at a landing place, or throw a bunch of rushes to some remarkable tree as an offering to the spirit that dwells within it. And in all such cases we must remember that to the savage mind the word spirit still means what it has half ceased to mean with us through long misuse—the actual ghost or surviving double of a departed tribesman. Worship, it seems to me, lies at the very root of religion, as distinguished from mere mythology; and the basis or core of worship is surely offering—that is to say, the propitiation of the ghost by just such gifts of food, drink, slaves, or women as the savage would naturally make to a living chief with whom he desired to curry favor.

I do not wish to deny, however, that in later stages of evolution the worship or reverence once paid to the ghost or spirit may come to be envisaged in the minds of devotees as worship or reverence paid to the actual trunk or to some vague sanctity of the surrounding forest. Thus the Yakuts of Siberia hang iron, brass,

* Primitive Culture, vol. i, p. 221.

† Darwin, Voyage of the Beagle, p. 68.

and shiny trinkets on any very large and conspicuous tree; they sacrifice horses and oxen under its spreading branches, fixing the heads on the boughs; and they chant extemporized songs to the Spirit of the Wood, to whom they dedicate offerings of horsehair, an emblematic devotion of their most valued possession.* Yet even here we see from the essentially religious act of sacrifice that a ghost is supposed to reside in the tree; and it would take a very delicate investigation indeed to show that in any particular case under examination *no* interment ever took place under the sacred tree. Whenever we see a shaped stone standing at the head of a little mound or diminutive barrow, we naturally infer that a burial has taken place there; whenever we see a sacred tree, unless grave reason exist to the contrary, we naturally infer a ghost and an interment. For the case stands thus: We know that in many instances savages inter their dead under the shade of great trees. We know that such trees are thereafter often accounted sacred. We know that young shrubs or bushes are frequently planted on graves in all countries. We know that whatever comes up on or out of the grave of a relative is counted as an embodiment or representative of the ghost within it. The presumption is therefore in favor of any particular sacred tree being of funereal origin and significance; and the *onus* of proving the opposite lies with the person who asserts some more occult and less obvious explanation.

Even where newly grown trees acquire a factitious or artificial sanctity, one can still see through the account some abiding relic of the same antique funereal origin. For instance, we learn that when our old friends the Kandhs settle a new village, a sacred cotton tree must be planted with solemn rites, and beneath it is placed the stone which enshrines and embodies the village deity.† Now, what is this stone? Possibly, to be sure, a mere casual bowlder, picked out at haphazard; but far more probably, as all analogy would show, the holy monolith or headstone of some ancient chief of the parent village. Nothing is more common than for migrating people to carry with them their sacred stones, their country's gods, their lares and penates, their ark, their teraphim; nothing more common than to take up the bones of their Josephs out of Egypt for interment in the new land which their lords and gods give them. In any case, however, be this as it may, the performance under the cotton tree is clearly on the very face of it a mimic interment. Considering what we know in other ways of the Kandhs, it would not surprise one to learn that a guardian deity used once to be provided for the new village by

* Tylor, Primitive Culture, vol. i, p. 224, quoting Castrén.

† Ibid., p. 225.

the simple process of slaughtering a superfluous meriah at the stone, exactly as in mediæval Europe, and long before a guardian spirit was provided for a bridge, a town wall, or any other important building, by immuring a human victim alive into the solid masonry—a curious and horrible superstition to which I shall have occasion to recur more fully further on in my argument.

Rome herself had such a sacred foundation tree—the holy fig of Romulus—whose very name connected it at once with the origin of the city; and so closely was it bound up in the popular mind with the fortunes of the state, that the withering of its trunk was regarded in the light of a public calamity. So, too, to this day, London has still her London Stone, which probably dates back to the earliest ages of the Roman town, or of the little Celtic village that once preceded it. This London Stone was for ages considered as the representative and embodiment of the entire community. Proclamations and other important businesses of state were transacted from its top; the defendant in trials at the Lord Mayor's court was summoned to attend from London Stone, as though the stone itself spoke with the united voice of the assembled citizens. Of the similar sacred stone at Bovey Tracey in Devonshire, Ormerod tells us that the mayor, on the first day of his tenure of office, used to ride round it and strike it with a stick. According to the Totnes Times of May 13, 1882, the young men of the town were compelled on the same day to kiss the magic stone, and to pledge allegiance in upholding the ancient rights and privileges of Bovey.* In these two cases we can clearly observe that stone and tree alike are regarded as the embodiment of the city, town, or village; and, as I believe, they derive their sanctity from the foundation god or spirit, who, as I shall have occasion to show hereafter, was probably killed on the spot, to provide a specific or artificial deity for the new creation.

Elsewhere we get still clearer evidence that it is the ghost, not the mere tree, to whom the adoration of the worshipers is primarily offered. "A clump of larches on a Siberian steppe," says Mr. Tylor, "is the chosen sanctuary of a Turanian tribe. But beneath it stand gayly decked little idols in warm fur coats, each set up under a great tree, on whose branches hang offerings of reindeer hides and household goods."† Clearly these idols represent the ancestral spirits protected from the rigor of the climate, as in life, by their thick fur coverings, and supplied by their relations with all that is necessary to make existence comfort-

* See Gomme, Village Community, p. 218; Ormerod, Archæology of Eastern Dartmoor, p. 11; and an article on London Stone by myself in Longman's Magazine.

† Primitive Culture, vol. ii, p. 224.

able for them in the new world they are supposed after death to inhabit.

Even more striking and conclusive, from our present point of view, is another of Mr. Tylor's well-selected cases. "In Esthonian districts," he says, "within the present century, the traveler might often see the sacred tree, generally an ancient lime, oak, or ash, standing inviolate in a sheltered spot near the dwelling-house; and old memories are handed down of the time when the first blood of a slaughtered beast was sprinkled on its roots that the cattle might prosper, or when an offering was laid beneath the holy linden, on the stone where the worshiper knelt on his bare knees, moving from east to west and back, which stone he kissed thrice when he had said, 'Receive the food as an offering!'"* To this case I say confidently, "Either ancestral spirits or the devil." Within the last two hundred years, indeed, there were old men in Gothland who would still go to pray under a great tree, as their forefathers had done in their time before them.

That single sentence of Mr. Duff Macdonald's already quoted, tells us more about the meaning of all these rites than pages of conjectural talk as to indwelling divinities. "It is the great tree at the veranda of the dead man's house," says this acute and original observer, "that is their temple; and if no tree grow there, they erect a little shade, and there perform their simple rites."† Mr. Macdonald has lived long among the people whose faith and practice he so clearly describes. He thoroughly understands their ideas and point of view; and I confess I attach a great deal more importance to his trained evidence in such a delicate matter than to a vast amount of uncertain classical argument. Moreover, the Blantyre negroes are still in the most primitive stage of religion; the process of god-making goes on among them to this hour as an every-day occurrence. We catch the phenomenon of the manufacture of deity in the earliest stages of its evolution.

On the whole, then, I think all the evidence is congruous with the theory that tree worship originated in ancestor worship or ghost worship, and with no alternative theory whatsoever. This is the hypothesis that fits all the facts, harmonizes all the discrepancies, and reduces to a plain meaning all the seeming absurdities of strange savage creeds and still stranger ceremonies. And to say the truth, no other hypothesis as to the origin of worship has ever been offered. Mr. Spencer's ghost theory, independently arrived at almost simultaneously by Mr. William Simpson, alone gives us a real explanation of the facts under notice. We find ourselves face to face at the outset with the very curious phenomenon of early races who people the whole world with imagi-

* Primitive Culture, vol. i, p. 224.

† Africana, vol. i, p. 59.

nary or nonexistent beings of a most shadowy description, and who treat these queer creatures of their own fancy with such respect and tenderness that they actually offer to them food and drink, and all the other things the savage holds most dear, out of pure apparent superabundance of philanthropy. Why on earth should they take the trouble to begin making presents of food and drink to mere wood-spirits or oreads with whom they had no earthly connection or interest of any sort? Here, as elsewhere, *c'est le premier pas qui coûte.* The offerings made to tree-spirits are precisely the same in kind as the offerings made to dead relations. Dead relations are buried under trees; the nearer we get to primitive customs, the more do we see that the tree-spirit *is* the ghost, and the more does everybody who has anything to do with him recognize and admit the patent fact. It is only when we have moved very far away from primitive usage and primitive modes of thought, that we begin to find tree-gods whose ghostliness is uncertain, and tales about their origin in which their former humanity is ignored or forgotten. The lowest savages never seem to harbor the faintest doubt that the gods whom they worship in tree or stone or temple are nothing more or less than their own ghostly ancestors.

Again, all the prerogatives which Mr. Frazer assigns to sacred trees* are also prerogatives of the deified ancestor. Thus, trees or tree-spirits are believed to give rain and sunshine. But we saw this was precisely the function of the ancestral ghosts among Mr. Duff Macdonald's Blantyre negroes, as indeed it is in endless other cases which I need hardly recall to the anthropological reader.† Once more, tree-spirits make the crops grow. Of this belief Mr. Frazer gives many interesting examples. Among the Mundaris, "the grove deities are held responsible for the crops, and are especially honored at all the great agricultural festivals." Swedish peasants stick a leafy branch in each furrow of their cornfields, believing that this will insure an abundant crop. Among the tribes of Gilgit in India, the sacred tree is a species of cedar—as usual an evergreen—and at the beginning of sowing, the people mix their seed-corn with sprigs of this holy conifer, and smoke it all above a bonfire of the sacred cedar wood. But all this goes on all fours with the common belief, on which I need not further enlarge, that it is the deified ancestors who make the earth bring forth her increase, and that all crops are the immediate gift of the "compassionate father," to whom the savage prays for the simple boons which make up all his happiness. Furthermore, the tree-spirit causes the herds to multiply, and blesses women with many

* The Golden Bough, vol. i, p. 66.

† See Herbert Spencer, Principles of Sociology, vol. i, part i, *passim.*

children. But this is a natural function of the ancestral ghosts, who, as the fathers of the tribe, are often—nay, one may even say habitually—envisaged under phallic guises. It is also a well-known function of the sacred stones, which originate in standing stones or grave slabs (as I have endeavored to show elsewhere), and which are universally regarded as of phallic potency. Indeed, to this day barren women in Brittany go to pray at ancient monoliths (thinly Christianized by having a small cross stuck on top) for the birth of children, which, says the Hebrew poet appositely, "are the gift of Jahveh."* Thus every one of the attributes claimed for the tree-spirits turns out on examination to be also an attribute of the ancestral ghost.

There are, I think, three main objects of human worship all the world over. The first is the ghost, or actual soul of the dead man, which gets sublimated or magnified in course of time into the spirit or shade, and then into the god. The second is the sacred stone. The third is the sacred tree. And these three are one. The ghost is the core and central reality of the whole vast superstructure of faith and practice. The sacred stone derives its sanctity from standing at the head of the dead man's grave. The sacred tree owes its position equally to its identification with the spirit of the chief or father who lies buried beneath it. In the striking and almost prophetic words of a great poet, God is indeed "the shade cast by the soul of man."†

How easily these three forms of primitive godhead run into one another has already been abundantly pointed out in many departments. The whole of The Golden Bough is from one point of view one long exposition of the interchangeability of the man-god and the tree-spirit or corn-spirit—an interchangeability which may surprise us the less when we remember that to this day one half of Christendom confidently identifies its own man-god with a piece of consecrated wheaten wafer. Mr. Frazer shows us how the slain god and the corn or the tree absolutely merge in the minds of their worshipers, so that at last it becomes almost impossible to separate them in thought one from the other. I believe the same thing to be true of sacred stones. Men worshiped stones, identified stones with their fathers, talked of themselves as descended from stones, looked upon the stones with affection and reverence, prayed to them, made gifts to them of wine and ghee, of milk and honey, till they almost forgot there was ever any difference at all to speak of between stones and humanity. The Laches,

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* Priapus, the garden god, is a phallic deity: the ark of Khem represents a garden, and Khem himself is always phallic. Fertility, I take it, is the common note of all these conceptions.

† Swinburne, Songs before Sunrise.

says Piedrahita, "worshiped every stone as a god, as they said that they had all been men." Arriaga tells us the ancient Peruvians paid honor to "very large stones, saying that they were once men." In the American Report of the Bureau of Ethnology for 1880, several stories are told as to the metamorphosis of men into stones from the Iroquois legends. According to Dorman, the Oneidas and Dakotas claim descent from stones, to which they ascribe both sense and animation. What is all this but early men's way of expressing the fact that these stones which they worship represent the ghosts of their deceased ancestors? Sometimes, indeed, we get an interesting connecting link, as in Arriaga's pregnant statement that the Marcayoc or idol worshiped in Peru as the patron of the village "is sometimes a stone and sometimes a mummy"; in other words, it depended upon circumstances whether the people reverenced the body itself or the gravestone that covered it."*

And if men become stones, so too do stones give birth to men. We get a classical instance of this in the legend of Deucalion. Beside the road, near the city of the Panopæans, lay the stones out of which Prometheus made men. Manke, the first man in the Mitchell Island, came out of a stone. On Francis Island, says Mr. Turner, "close by the temple there was a seven-feet-long beach sandstone slab erected, before which offerings were laid as the people united for prayer"; and the natives here told him that one of their gods had made stones become men. "In Melanesia," says Mr. Andrew Lang, "matters are so mixed that it is not easy to decide whether a worshipful stone is the dwelling of a dead man's soul, or is of spiritual merit in itself, or whether the stone is the spirit's outward part or organ." And, indeed, a sort of general confusion between the stone, the tree, the ghost, and the ancestor at last seems to pervade the mind of the savage everywhere. "The curious anthropomorphic idea of stones being husbands and wives," as Mr. Tylor calls it—an idea familiar to the Fijians as to the Peruvians and Lapps—is surely explicable at once by the existence of headstones to men and women, and the confusion between the mark and the ghost it commemorates.

I have introduced this question of the sacred stone at so great length, mainly because of the close analogy which subsists between it and the similar question of the sacred tree. For, just in like fashion, Mr. Galton tells us how on one of his South African wanderings he passed "a magnificent tree. It was the parent of all the Damaras. . . . The savages danced round and round it in great delight."† But I also wish to point out how the general

* Arriaga, Extirpacion de la Idolatria, p. 89.

† Galton, Narrative of an Explorer, pp. 188, 204.

interchangeability of all the various forms of the ghost extends even to what might seem the impossible cases of the sacred stone and the corn-spirit. At first sight it would almost look as if there could be no conceivable community of any sort between these two very distinct and unlike manifestations of the ancestral ghost or the slain man-god. Yet in Mr. Gregor's Folk Lore of the Northeast of Scotland, I find the following very interesting passage, which clearly shows the occasional equivalence of the two ideas: "It was believed by some that a very mysterious animal, which when met with by the reapers among the corn had the appearance of *a gray stone*, but which could change its shape, lived among the corn. When met with, a small quantity of the crop was left standing around it, and the ears of grain only were cut off. This animal looks like the hedgehog."* Readers of The Golden Bough will be very familiar with this "mysterious animal," which is in point of fact nothing more or less than the corn-spirit itself, hiding, as it were, in its own vegetal embodiment.† The rye wolf, the harvest goat, the cock, pig, and horse, are all various avatars of this polymorphic spirit; and now, in the interesting Scotch case above quoted, we find him similarly and unexpectedly equated with a gray stone.

There is one more point of considerable importance to which I wish to call attention in passing, before I quit this part of my subject, and that is the question of the immolation of the man-god as a deliberate mode of producing a corn-spirit or guardian soul of vegetation for the growing crops. Of the practice itself there can not now remain the slightest doubt after the brilliant demonstration given by Mr. Frazer in his epoch-making work. But it may have seemed a hard saying to some when I attributed these immolations to the definite desire to manufacture artificially an indwelling spirit for the growing corn. Nevertheless, such definite manufacture would seem much less curious to primitive man than to his modern and more squeamish or humane descendants. We must recollect that the chiefs or kings of primitive peoples, being the offspring of the deified ghosts who form the tribal gods, are therefore necessarily divine. That kings are gods, Mr. Frazer has now abundantly shown us; and we learned from Mr. Loftie how the divinity of the Pharaoh formed a prime element in the faith of the pyramid-builders in Egypt. Now, this being so, nothing is more natural, when you want a departmental god for any particular purpose, than to release before its time one of these divine souls from its fleshly tabernacle, and turn it loose upon space to perform whatever work you may happen to require

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* Rev. Walter Gregor, Folk Lore of the Northeast of Scotland, p. 181.

† The Golden Bough, vol. i, p. 404, *seqq.*, and vol. ii, pp. 1–67.

of it. We must remember in this connection that primitive men really *believe* in the world and the life beyond the grave. To them it is all very ordinary reality. Thus, slaves are sacrificed on the tombs of their masters to bear them company in their ghostly life. "The practice of sending messengers to the world beyond the grave," says Mr. Macdonald, "is found on the west coast. A chief summons a slave, delivers to him a message, and then cuts off his head. If the chief forgets anything that he wanted to say, he sends another slave as a postscript." Nor are all the victims unwilling sufferers. Wives perform suttee of their own accord on the pyres of their husbands; young men offered themselves voluntarily for the fatherland to Baal; Marcus Curtius devoted himself by leaping into the gulf in the forum.

A curious analogy elsewhere will make this point, I hope, both clearer and more certain. It is a practice with early or undeveloped races to supply an artificial guardian god or spirit for a building, in precisely the same way as I suppose the guardian god or spirit for the growing crops to have been supplied by agriculturists—namely, by killing a human victim, whose blood was sometimes actually used as cement for the walls, so that his ghost might, as it were, be implicitly bound up in the very stones and fabric of the building. There is a legend current in Scotland, says Mr. Tylor,* that the Picts bathed their foundation stones with human blood; and St. Columba, not much more advanced in thought than his heathen contemporaries, "found it necessary to bury St. Oran alive beneath the foundation of his monastery." As the chronicler phrases it, "Columbkille said to his people, 'It would be well for us that our roots should pass into the earth here.' And he said to them, 'It is permitted to you that some one of you go under the earth to consecrate it.'" Oran accepted the sacrifice.† Even in modern Europe such usages survived late. When the broken dam of the Nogat had to be repaired in 1463, the peasants, being advised to throw in a living man, are said to have made a beggar drunk and utilized him for the purpose. Thuringian legend declares that to make the castle of Liebenstein fast and impregnable, a child was bought for hard money of its mother and walled in. Notice here the analogy to Kandh custom with the meriahs. The child was eating a cake while the masons were at work and it cried out, "Mother, I see thee still"; then after a little time, "Mother, I see thee a little still"; finally, as they put in the last stone, "Mother, now I see thee no more." The wall of Copenhagen, says Mr. Tylor, to whom I am indebted for most of these cases, sank as fast as it was built; so they took an innocent little girl, and set her at a table with toys and eatables; then, while she

* Primitive Culture, vol. i, p. 104.

† Reeves's Life of St. Columba, p. 288.

played and ate, twelve master masons closed a vault over her; and with clanging music the wall was raised, and stood firm ever afterward. In Italy, again, the bridge of Arta fell in time after time till they walled in the master builder's wife, the last point being a significant detail, which brings us very near to the sacrificial savage pattern. At Scutari, in Servia, once more, the fortress could only be satisfactorily built after a human victim was walled into it; so the three brothers who wrought at it decided to offer up the first of their wives who came to the place to bring them food. And so, too, in Welsh legend, Vortigern could not finish his tower till the foundation stone was wetted with the blood of a child born of a mother without a father—a common trait in the generation of man-gods.

In Polynesia, where we always stand nearer to the roots and beginning of things, Ellis heard that the central pillar of one of the temples at Maeva was planted upon the body of a human victim. Among the Dyaks of Borneo, a slave girl was crushed to death under the first post of a house. Even in Japan, a couple of centuries since, when a great wall was to be built, "some wretched slave would offer himself as a foundation." Observe here, too, the further important fact that the immolation in this case was apparently quite voluntary. Mr. Tylor, indeed, treats all these instances as though the victim were offered up to appease the earth-demons; but one of his own authorities, Mason, was told by an eye-witness that, at the building of the new city of Tavoy in Tennasserim, "a criminal was put in each post-hole to become a protecting demon." Here we have, I think, the more probable explanation, an explanation which exactly accords in every point with the principles and practice of the Kandhs and the other human-sacrificing savages.

In October, 1881, the king of Ashanti put fifty girls to death, that their blood might be mixed with the mud used to repair the royal palace, injured by an earthquake. "Some years ago, the piers of a railway bridge under construction in central India were twice washed away, when nearly finished, by the floods, and a rumor spread abroad among the Bheels of the neighboring jungles that one of them was to be seized and sacrificed by the engineers, who had received such manifest proof of mysterious opposition to their work."* Schrader says that when the great railway bridge over the Ganges was begun, every mother in India trembled for her child.† Mr. Baring-Gould has contributed a striking article on this subject to Murray's Magazine for March, 1887; and he differs from Mr. Tylor in attributing the practice of immolation (rightly, as I believe) to the desire to produce a protecting spirit

* Sir A. Lyall, Asiatic Studies, p. 19. † Clodd, Childhood of Religion, p. 268.

for the edifice to be erected.* Ubicini well defines a *stahic* as "the ghost of a person who has been immured in the walls of a building in order to make it more solid." †

It is not houses alone, however, that are thus protected by an artificially made guardian. The vikings used to "redden their rollers" with human blood. That is to say, when a warship was launched, human victims were bound to the rollers over which the galley was run down to the sea, so that the stem was sprinkled with their blood.‡ The last trace of such consecration among ourselves is the breaking of a wine-bottle over the ship's bows. Captain Cook found the South Sea Islanders similarly christened their war-canoes with the blood of human victims.

Furthermore, as the position of protecting spirit is rather a dignified and beatified one than otherwise, it is kept reasonably enough in the family of the king, the founder, or the master builder. This is a common trait in all stories of these human sacrifices, and it helps to bring them into line with the similar stories of corn-spirits and self-immolated gods. For it is the dearly beloved son that is especially chosen for such self-immolation. Thus, we read in the Book of Kings that when Hiel the Bethelite built Jericho, "he laid the foundation thereof in Abiram his firstborn, and set up the gates thereof in his youngest son Segub." And may we not put down in the same category the case of Remus, represented in legend as brother of Romulus, the founder of Rome?

To sum up, then, I would say in one word, while I accept in all their main results Mr. Frazer's remarkable conclusions, I believe that, in order to understand to the very bottom the origin of tree worship, we must directly affiliate it upon primitive ancestor or ghost worship, of which it is an aberrant and highly specialized offshoot.

[*Concluded.*]

ACCORDING to the English journal Iron, Lieutenant Apostolow, of the Russian navy, has some marvelous plans for expediting ocean navigation. He recently exhibited to some naval officers in Odessa a new style of ship, having no screw or paddle, but instead, "a kind of running electrical gear right round the vessel's hull under the water-line, and a revolving mechanism which will propel the ship from Liverpool to New York in twenty-eight hours." To those who are too timid to undertake this voyage, he offers the alternative of a submarine passage, "without rock, roll, or vibration, and with a good supply of oxygen and hydrogen during the short voyage."

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* See also Grimm, Teutonic Mythology, vol. ii, p. 844, and Folk Lore Record, vol. iii, p. 282.

† Ballades et Chants Populaires de la Roumanie, p. 198.

‡ Vigfusson and Powell, Corpus Poeticum Boreale, vol. i, p. 410.

THE STORY OF A COLONY FOR EPILEPTICS.

By EDITH SELLERS.

SOME twenty-seven years ago, a number of gentlemen interested in social and philanthropic questions met together at Bielefeld, in Westphalia, to consider what could be done to alleviate the sufferings of epileptic patients, and prevent their being a burden to themselves and to their fellows. Epilepsy was at that time alarmingly prevalent in North Germany, no less than one tenth per cent of the population being afflicted with the disease. There was hardly a village but had its epileptics, men, women, and children, who passed their days just waiting for the coming of those awful paroxysms, which rendered them at once the terror and the derision of their neighbors. Many of these people were full of life and energy, willing, nay, eager to work, for, as they well knew, in steady work lay their one chance of warding off the doom that threatened them. Every day epileptics sit with folded hands brings them the nearer to hopeless idiocy. It is this that renders their fate so infinitely pathetic. Work they must, unless they are to become insane; and there is no work for them to do! Masters do not care to run the risk of employing men who, at any moment, may be stricken helpless. Thus thousands are compelled to pass their days in enforced idleness, an idleness fraught with disaster to themselves, and with the loss of much good service to the community. It was to put an end to this state of things, so far at least as Westphalia was concerned, that the Bielefeld committee began its work. The problem its members had to face was how to arrange a condition of life under which the labor of epileptic patients might be rendered economically productive. This they set to work to solve in an eminently practical fashion, by opening a labor home for epileptics. This home, Bethel as it is called, has now developed into one of the most important labor colonies in Europe. What gives a special interest at present to Bethel is that a committee has just been formed for the purpose of establishing a similar institution in England.

Bethel was started in a very humble way. A small farm was bought at Sparenberg, near Bielefeld, with money raised by voluntary subscriptions, and there the first patients were installed. A committee of management was appointed to watch over the working of the Home, which was placed under the direction of Herr Unsöld, a kindly, energetic man, a practical farmer, too, as well as a skillful organizer. There were at first only four patients, but before many weeks had passed the house was full. The inmates all lived together as one family, and cultivated the

land attached to the homestead. The discipline maintained was of the least irksome kind, the men being allowed as much as possible to go their own way, so long as they obeyed the doctor's orders. Steady work and regular hours were, however, insisted upon, and the patients were required to pass the greater part of their time in the open air. They were supplied with light, nourishing food, and a moderate quantity of tea and coffee. No intoxicants were allowed to be brought to the farm, and only a limited amount of tobacco. The men were carefully guarded from everything that could excite or irritate them; and, at the same time, infinite trouble was taken to render their lives as bright and cheerful as possible. The beneficial effects of this *régime* were soon apparent. The physical and mental condition of the patients improved rapidly, and the attacks to which they were liable became less frequent and less severe. The fact of all around them being subject to the same misfortune as themselves, seemed to deprive that misfortune of half its terrors; a fit became merely an unimportant episode in life when it no longer rendered him whom it befell a pariah among his fellows.

The fame of the Labor Home, and of the good work being done there, soon spread through North Germany, and applications for admission arrived from all parts. By 1870 the success of the undertaking was so marked that the committee of management felt justified in reorganizing it on a much more extensive scale. An appeal for funds having been liberally responded to, a small estate adjoining the old homestead was bought, and on it a building was erected large enough to receive one hundred and eighty patients. The new home was placed under the care of the Westphalian Brotherhood, an order of laymen who devote themselves entirely to practical philanthropic work. So far the institution had been reserved entirely for men; it was now, however, resolved to admit both women and children. The new departure was not an unqualified success. Female epileptics are, oddly enough, much more difficult to manage than male: they are more passionate and less tractable; they seem, too, less able to grasp the fact that rules must be obeyed. Their somewhat flighty ways made them a disturbing element in Bethel; and it soon became evident that they must not be allowed to remain there in the same building as the men. Difficulties also arose in connection with the children, owing to the impossibility of keeping them apart from the older patients, some of whom were by no means desirable companions for them. A brief experience showed, too, that many disadvantages result from clubbing together in the same house a large number of patients of different ranks in life and in different stages of their common disease. The patients are required to contribute to the expenses of the Home according to

their means. This necessitates their being divided into classes; and it was found very difficult, when they were all living together, to provide first and second class patients with the comforts for which they paid, without exciting the jealousy of the third-class patients, many of whom are admitted free. And, what was much more serious, it was proved that people subject only to occasional attacks suffered severely from being brought into close contact with those who were already sunk in idiocy. Thus, there were strong reasons for making a radical change in the organization of the Labor Home; and, after much anxious consideration, its managers, principally by the influence of Dr. von Bodelschwingh, decided on a bold move. They resolved to give up the large new house entirely to the female patients, and to provide other homes for the boys and the men.

On one side of the Bethel estate the great Teutoburgian Forest stretches for miles away, forming a barrier, as it were, between it and the outside world. The forest is traversed by little valleys, each separated from its fellows by high ridges densely covered with trees. Before the colony was started the only human habitations to be found in these valleys were a few small homesteads and some Jäger-huts. Although, here and there, little patches had been cleared, no serious attempt had been made to bring the forest land under cultivation, the amount of labor required for the work being too great for any ordinary capitalist to be willing to undertake it. The Bethel institution, however, occupies a different position from that of an ordinary capitalist; its difficulty is to provide work for its workers, not workers for its work. Thus the forest offered it the very thing it stood most in need of—an almost boundless field for the employment of the unskilled labor of its epileptic patients. The land was supposed to be of little value; the managers of Bethel, therefore, secured upon easy terms the two valleys which lay nearest their estate, together with the houses and other buildings which stood there. Hither, by degrees, they transferred all their male patients. In compliance with the strongly expressed wish of the men, instead of building a few large houses for them to live in, it was decided to utilize the little homesteads which were already there and to erect others of a similar kind. The patients themselves were set to work, and soon quite an important village sprang up. There are cottages for the old, for the young, and for the middle-aged; for the mentally or physically feeble, and for the mentally or physically strong. Some are reserved entirely for imbeciles, while others, remote from the rest, are set aside for the hopelessly insane. There are, in fact, homes for people in all stages of the disease, homes, too, for people of all ranks and stations; for one of the great advantages of the cottage system now in force in Bethel—

the whole colony is Bethel—is that it admits of the most minute classification of patients. Each house is, to a certain extent, autonomous, the ten or twelve persons who live in it forming, as it were, a separate family. At the head of it is a House Father, generally a Westphalian Brother, who passes his whole time with the patients, working with them, and throwing himself heart and soul into their interests.

Meanwhile, Dr. von Bodelschwingh and his colleagues had been compelled to grapple with another serious difficulty. As the colony increased in size it became evident that, if it were to continue a success, other occupations besides agriculture must be provided. Some of the patients were too weak physically to bear the fatigue and exposure of an out-of-door life in winter; others, especially the artisans, manifested a decided distaste for the work. As it is of the utmost importance that epileptics should have congenial occupation, it was decided to open workshops, so that the men might be able to practice the special craft in which they had been trained, or for which they had the most natural aptitude. One by one various industries have been established in the colony. In very early days a regular building department was organized, and attached to it are now workshops for painters, joiners, locksmiths, and cabinet-makers, as well as a brick-kiln and a sawmill. Shoemakers' and tailors' shops have also been opened. A linen mill, too, now gives occupation to a number of the colonists, while the printing office and the book-binding works are the pride of the whole place. Thus, when an artisan now arrives in Bethel he can at once be set to some work to which he is accustomed, a fact which contributes not a little to his happiness, for an epileptic, after a certain age, seems almost incapable of turning his hand to a new occupation. Most of the things made are consumed in the colony, but if there is any surplus stock it is sold in Bielefeld. The organizing of these industries was no easy task. An attempt was made at first to employ as overseers in the workshops such of the patients as were skilled artisans, but it proved a failure. Epileptics are, as a rule, lacking in initiative; and they have neither the patience nor the self-control necessary for directing the labor of others, especially when these others are themselves of defective intellect. It therefore became necessary to appoint a paid overseer for each factory, an arrangement which has materially increased the working expenses of the colony. From first to last, in fact, these workshops have proved a somewhat costly experiment. In spite of the most rigid economy in their management, not only are they now worked at a loss, but there is no prospect of their ever becoming self-supporting. One serious expense in connection with them is the salaries of the labor overseers, another is the enormous amount of raw material

that is wasted. It must not be forgotten that a number of the people employed, even the most skilled among them, are at times quite irresponsible for their actions. A man may do good steady work for months, and then, for some inexplicable reason, suddenly seize the coat he is sewing or the book he is binding and tear it into atoms. Work done under such conditions can never be lucrative. But although financially the workshops are a failure, in every other respect they are a decided success. They give variety and interest to life in the colony, and they have indirectly a most beneficial effect upon the *morale* of the patients, many of whom have become much more alert and mentally vigorous since they have been working at their old trades.

Agriculture, however, is, and always must be, the staple industry of the colony; and as agriculturists these epileptics are certainly doing good work—work, too, which from year to year tends to become more productive. They have already cleared and brought to a state of high cultivation much of the land they possess in the forest, and they have completely transformed the great Senne. Until they took it in hand this marshy common produced nothing but thistles and heather; now it yields fairly good crops of barley, oats, and potatoes. Parts of it have even been turned—and with the best results—into vegetable gardens, flower gardens, and fruit orchards. Market gardening is undoubtedly the most profitable industry carried on in the colony. It is, too, the calling for which the majority of male epileptic patients show the most marked preference. Men who are dead to all other emotions seem to derive intense delight from their own special allotments. They will work in them from morning until night, and there is neither bound nor limit to the care they bestow on them. They watch over their plants and seedlings with infinite tenderness, and talk about their early vegetables and first strawberries with enthusiasm. The crops they obtain are surprisingly good considering the soil they have to deal with. Not only do they supply the entire colony with the fruit and vegetables it requires, but they carry on a thriving trade with the manufacturing towns in the neighborhood. For fifty miles around the fruit and the flowers raised in the Bethel hothouses are in great request. In connection with the flower garden, a large building is set aside for drying seeds and storing bulbs, a most profitable undertaking. The colonists, in addition to raising their own vegetables, grow their own corn, feed their own cattle, and make their own butter and cheese. Their well-stocked farms are most delightful places, and the dairies attached to them are perfect models of what dairies should be.

One of the most difficult tasks which fall to the lot of the managers of Bethel is that of providing suitable occupation for

the women. There are few things female epileptics are capable of doing. They can wash, clean, and sew, though only under supervision; but they dislike gardening, and cooking is entirely beyond their power. They can not be relied upon to lay tables, or to do anything, in fact, which requires memory or attention. Their helplessness, however, is evidently merely the result of previous neglect; for the young girls who are trained at Bethel exhibit comparatively few of the defects which characterize the women who go there later in life. First and second class female patients are now lodged in large cottages, but the third class still remain in the great building which was originally assigned to them. The first floor of it has been turned into a sort of restaurant for the whole of the colony, six hundred of the patients dining there every day, and the food for all the houses in the immediate neighborhood being cooked there. The women and girls are entirely under the care of the Deaconesses, some fifty of whom are stationed in the colony.

The pleasantest part of Bethel—the one, too, in which perhaps the most valuable work is being done—is that set aside for children. The brightness and gayety which prevail there are simply indescribable. Far from being depressed by their affliction, the little patients seem to look at life through glasses of even brighter rose than healthy children. They are more excitable, more keenly alert, more easily moved by every passing emotion. They literally dance with delight at the merest trifles, and make their playground ring with peals of the merriest laughter. Not but that there are specks in the sunshine even there, for on one and all the fell disease casts its shadow. There are wild outbursts of grief just when the games go most gayly, heart-breaking sobs of which no one knows the cause. In the midst of a class, a bright, intelligent girl falls to the ground a shrieking maniac; a boy, beaming with light-hearted fun, lifts his bat, and in a trice he is a thing strong men might shrink from. Wherever these children may be, whether at work or at play, some guardian must always be at hand, for no one knows the moment at which they may be stricken. About one hundred and fifty children are now attending the schools in Bethel. There they are thoroughly well taught according to their capacity. Some of them learn with quite marvelous quickness; but, unfortunately, they forget what they learn with equal speed. The greatest care is taken in cultivating any talent they may possess; and special importance is attached to their acquiring dexterity in the use of their fingers. When they have passed through the ordinary course of study, they are sent to a sort of technical school, where they are regularly trained for some handicraft which will enable them later to take their place as self-supporting colonists.

It is noteworthy that none of the children who have been brought up in Bethel have ever lost their reason, at least not so long as they have remained in the institution. Indeed, the medical statistics prove that not three per cent of the epileptic patients, of all ages, who take up their permanent residence in the colony, become insane. Unfortunately, thirty per cent of them are already imbecile when they arrive, and of these very few recover their senses. This success in warding off insanity is not so much the result of any special medical treatment the patients receive in Bethel as of their being kept steadily at work and being preserved from all unwholesome excitement. But cheering as the medical reports on the condition of the patients are in one respect, in another they are decidedly depressing. The investigations into the causes and symptoms of epilepsy which have been carried on in Bethel have led to the adoption of remedies by which the sufferings it entails are materially lessened, but, so far at least, no cure for the disease has been discovered. By submitting to the conditions of life as arranged in the colony, epilepsy may be rendered dormant for years; those suffering from it may, for all practical purposes, become as able as their fellows; but the taint of the disease still remains. Worry or excitement may at any time lead to a return of the disorder. Out of 3,300 patients treated in Bethel, only 228 were dismissed as cured, and even of these several were obliged later to return to the institution.

Great hopes are entertained by the managers of Bethel that in time the colony may become self-supporting. So far, however, its expenses have been twice as great as its regular income. During the year 1890 there were 1,277 patients in Bethel, 1,073 of whom were there on January 1, 1891. Of these, the first class paid one hundred pounds a year, the second class fifty pounds, and the third class twenty-one pounds a year or less. These terms include board, lodging, and medical attendance for all classes, as well as clothing and washing for the third class. Only twenty-five per cent of the patients belong to the first and second classes, and the remaining seventy-five per cent to the third class. Although theoretically the terms for the lowest class are twenty-one pounds a year, as no one is refused admittance merely because he can not pay the fees, the majority of those belonging to it pay considerably less, and many of them nothing at all. During the year 1890 the patients, roughly speaking, paid on an average twelve pounds per head, whereas they cost on an average twenty-five pounds per head. The working expenses of the colony for that year were £31,155, while the fees paid by the patients amount only to £12,351. To this amount must be added the value of the articles produced in the colony and sold—viz., £3,452. At the end of the year there would thus have been a deficit of £15,352, if out-

side aid had not been given. The Provincial Stände, which send their pauper imbeciles to Bethel, however, voted a contribution of £2,838, and £12,260 was raised by voluntary subscriptions. Three thousand four hundred and fifty-two pounds does not, of course, represent the full value of the work done by the colonists in the course of a year. Their labor is in a great measure embodied in the real property now held by the institution, in the two thousand acres of land which have been brought under cultivation, and the various houses and other buildings which have been erected in the colony, together with their furniture, etc. Much of this real property is the produce of epileptic labor, and its value is estimated at £133,429. If Bethel had restricted its enterprise to farming and market gardening, its balance-sheet would no doubt be more satisfactory reading; but, on the other hand, its usefulness as an institution would have been impaired. The colony was established as a philanthropic experiment, and as such it is a brilliant success. Those responsible for its management have acted wisely in choosing to postpone indefinitely the day of its economic independence, rather than sacrifice, in the slightest degree, the interests of the sufferers under their care.

The colony is at present in a most flourishing state, and it is increasing in size and usefulness from year to year. The village itself is charming, with its quaintly formed, bright-colored houses, which stand out in bold relief from the dark forest behind them. The Church, the headquarters of the Westphalian Brothers, and Sarepta, the home of the Deaconesses, are quite imposing buildings; and there are also public baths, a hospital, a museum, and even a savings-bank. Hermon and Bethany, the cottages reserved for first-class patients, are most attractive abodes; they stand in the midst of beautiful gardens, and have lawn-tennis courts attached. It is, however, the air of general prosperity about the place which renders it so delightful. All the people are well clothed—well fed, too, as one may see by their faces. All sorts and conditions of men are there, all hard at work—at work, too, with their hands, be they princes or beggars. That is the law as of the Medes and Persians: there is no "leisured" class in Bethel. It is this incessant work and bustle that makes the village so cheerful. The people have no time to brood, no time to wonder why their lot should be cast thus apart from their fellows. Considering their condition, it is startling to note the expression of content—nay, happiness—on the faces of many of these colonists; even the imbeciles among them seem at least to have found rest. Of course, it is not always thus; ghastly scenes are witnessed from time to time; and here and there—but only in those hidden nooks remote from other dwellings—one comes across a something that is hardly human. These eleven hundred colonists

form a wonderfully united little community. The sense of their common affliction seems to draw them very close together, while the knowledge of their own dependence teaches them to be ever ready to give a helping hand—to give it, too, gently, tenderly. Epileptics have a terrible cross to bear at the best; but in Bethel it is lighter than elsewhere. In the world such people are burdens on the labor of others, pariahs whom all men shun; in their own colony, however, they are respected citizens doing good work in the world, and living upon terms of equality and sympathy with their fellows.—*The Contemporary Review.*

THE BROOKLYN ETHICAL ASSOCIATION.

By LEWIS G. JANES, M. D.

THE philosophical evolutionist looks for the regeneration of society and the advancement of civilization by means of the voluntary action of individuals, rather than by the multiplication of state agencies. Society, to him, is not an artificial mechanism, held together by legal compulsion, but an organic growth, depending for its strength and utility upon the intelligent volition of its constituent units. To effect results, however, the units must not illustrate an individualism which is antagonistic and repellent, but an individualism inspired by the social sentiment—the desire and purpose to co-operate voluntarily in all wise efforts for the common good.

As the coercive functions of the state decline, and the divorce of church and government becomes more complete, efforts for the moral and social improvement of the people are relegated more and more to the control of voluntary organizations. This is especially true as the importance and indeed the necessity of applying the method of science to the solution of the great social and political problems of the day is recognized by the public mind. It is not surprising, therefore, in a country where the government is "of the people, by the people, and for the people," to note that the education of the people in religious matters has already passed out of the control of the state, while in social and political concerns voluntary associations are rapidly taking the place of the state in the instruction of the people, and even in the enforcement of the law and the administration of justice. The Citizens' Association, the Society for the Prevention of Crime, the Societies for the Prevention of Cruelty to Children and to Animals, labor organizations and arbitration committees, the Prison Reform Association, and the Social Science Association are factors in the training of our people for good citizenship, and in the administration of

affairs which are not second in importance to the authorized and legalized agencies of the state.

Among the voluntary associations which are doing effective work in the moral education of the people, and in the wise direction of public sentiment toward the practical solution of our social and political problems, the Ethical Society holds a unique and important place. For a goodly number of intelligent minds—agnostics and independents in their theological views—it has already to a large extent supplanted the Church as an agency for moral, and in a qualified and unconventional sense, of religious education. Its aim is broader than that of any of the organizations devoted to specific social or political reforms; it strives not only to afford the means for wise altruistic efforts in applying ethical data to the practical problems of social life, but also, and in a special sense, to discover the true scientific and philosophical principles which underlie applied ethics and sociology.

The work of Prof. Felix Adler and his able coadjutors, Dr. Stanton Coit, Mr. Salter, Mr. Sheldon, Mr. Weston, and Mr. Mangasarian, as teachers of a noble type of ethical theory, and earnest workers among the poor and ignorant of our great cities, is worthy of all praise, and has received the cordial recognition of many who are not in full sympathy with the philosophical foundation on which the able and scholarly teaching of Prof. Adler and his disciples appears to be based.

The Brooklyn Ethical Association, which is the subject of this sketch, has no connection, however, except through its general sympathetic attitude toward noble workers for common ends, with the societies over which Prof. Adler and his devoted associates preside. This association, which has become known to the public through its efforts to bring the problems of ethics, sociology, and religion to the test of scientific and evolutionary principles, is itself a product and illustration of natural development. It did not spring, full grown, from the brain of any individual, and its ultimate success has doubtless far exceeded the expectations of any who were promoters of the earliest stages of its growth. Its original nucleus was an adult class in ethics connected with the Sunday school of the Second Unitarian Church of Brooklyn, N. Y., of which the Rev. John W. Chadwick has been for twenty-seven years the honored minister. For several years this class had been conducted by Dr. Lewis G. Janes, using as text-books such suggestive works as Spencer's Data of Ethics, Mill on Liberty, Graham's Creed of Science, Sidgwick's History of Ethics, and others of a similar character.

In the season of 1881–'82 this class was temporarily in charge of Prof. Franklin W. Hooper, now the able manager of the Brooklyn Institute of Arts and Sciences, and to him more than

any other individual the organization and initiatory success of the association are due. He was made its first president, and presided over its deliberations for two years, being succeeded for a like term by Mr. Z. Sidney Sampson. At the close of Mr. Sampson's second term, in the fall of 1885, Dr. Lewis G. Janes was chosen as his successor, and has been re-elected in each succeeding year.

The association, which at first assumed the rather formidable title of "The Association for the Promotion of Moral and Spiritual Education," continuing for a time its Sunday morning meetings at the Second Unitarian Church, met also in private parlors on Friday evenings, and during its first season devoted its sessions to the discussion of certain fundamental philosophical problems and to the study of Herbert Spencer's work on The Study of Sociology. The doctrine of evolution, which, indeed, had entered largely into the discussion of ethical topics in the previous studies of the Sunday-school class, thus inspired and directed the work of the association from its inception. Its members, often differing in theology, in politics, and in speculative views, were agreed in finding in the scientific method, especially as inspired and illumined by the evolution idea, a common *pou sto*, on which they could unite in fruitful study and discussion.

From 1883 to 1885 the association continued its meetings in private parlors, studying the natural evolution and ethical foundations of the Oriental religions, with preliminary lectures on the Origin of the Religious Idea, and Fetichism; Confucianism, Brahmanism, Buddhism, Zoroastrianism, the Religions of Ancient Egypt, and the Hebrew Religion were thus reviewed during the first season, several evenings being devoted to each topic. At one meeting Prof. Charles D. B. Mills, of Syracuse, gave an interesting lecture on Our Aryan Home, and at another Baboo Amrita Lal Roy, now the editor of the Hindoo Magazine in Calcutta, described the social and religious status of his people in India at the present day. The work of the next season involved a similar treatment of the Greek and Roman Religions, Primitive Christianity, Gnosticism, and Neo-Platonism. The lectures on Primitive Christianity, which were delivered by Dr. Janes, were subsequently compiled in book form and have had a considerable sale. Other occasional lectures of this period were printed in the Westminster Review, the Index, Boston Commonwealth, Unitarian Review, and elsewhere, thus reaching and creating a larger public interest in the association and its work. As one of the results of its Oriental studies, the association obtained honorable recognition abroad, and became the authorized recipient of the first complete English translation of that monumental work, the great epic poem of India, the Mahabharâta, published, mainly for gratuitous distribution, by the Datavya Bharâta Karyalaya, at the

head of which is its devoted translator, Baboo Pratapa Chandra Roy, of Calcutta. This work has now reached upward of four thousand pages, and is hardly more than two thirds completed.

In subsequent seasons the association studied the historical development of the Rational Movement in Religion, Social Problems, viewed in the Light of History, and the works of Ralph Waldo Emerson, Thomas Carlyle, and "George Eliot." Its membership had expanded so far beyond the original thirty or forty who comprised the Sunday-school class that private parlors were too contracted for its meetings, and by the courtesy of the trustees of the Second Unitarian Church they were transferred, first to the vestry, and subsequently to the main auditorium of the church. Here were inaugurated, in the fall of 1888, on Sunday evenings, the noteworthy lectures and discussions on Evolution which attracted the favorable attention of many of the leading minds in Europe and America to the association and its work.

Mr. Herbert Spencer, to whom the programme of that year was submitted, gave it his cordial indorsement, saying in his very appreciative letter: "The spread of the doctrine of evolution is both surprising and encouraging. The mode of presentation seems to me admirably adapted for popularizing evolution views, and it will, I think, be a great pity if the effect of such presentation should be limited to a few listeners in Brooklyn." Acting upon this suggestion, the association, which had now formally adopted the less formidable title of "The Brooklyn Ethical Association," commenced the regular publication of its lectures, each one being first issued in cheap pamphlet form, and the lectures of each season subsequently compiled in handsome cloth bindings. Four noble volumes now constitute the lasting memorial of the work of the association for the past four years in popularizing evolution views. Under the titles, respectively, of Evolution, Sociology, Evolution in Science, Philosophy, and Art, and Man and the State, the leading problems of physics, biology, philosophy, sociology, religion, ethics, and practical politics have been ably treated from the standpoint of the philosophical evolutionist.

Much of the work, and admittedly some of the best work of the association, has been done by its active members, among whom distinctions would be invidious. This work, which has involved much time and study, has been rendered gratuitously by the lecturers. Others, not active members of the association, whose names stand in the first rank of the disciples of science and advocates of evolution, have cordially co-operated, among whom we may mention Prof. John Fiske,* Prof. Joseph Le Conte,* Prof. E. D. Cope,* Mr. Daniel Greenleaf Thompson, Mr. Garret P. Serviss,

* Corresponding members.

Dr. Rossiter W. Raymond, Mr. C. Staniland Wake,* Prof. George Gunton, Rev. John C. Kimball,* Prof. Thomas Davidson; Dr. E. Benjamin Andrews, President of Brown University; Dr. Charles De Garmo, President of Swarthmore College; Dr. L. A. W. Alleman, Dr. Francis Ellingwood Abbott, Prof. Joseph Henry Allen, Mr. Edwin D. Mead, Mr. Arthur E. Kennelly, Mr. Thaddeus B. Wakeman, Rev. Samuel J. Barrows, Mr. Daniel S. Remsen, Hon. Roswell G. Horr, Hon. Edward M. Shepard, Hon. William J. Coombs, Prof. Amos G. Warner,* Dr. T. D. Crothers, Rev. Nicholas P. Gilman, Rev. E. P. Powell,* Mr. J. W. Sullivan, Miss Eliza A. Youmans,* and Mrs. Mary Treat.

The association has been fortunate, not only in the character and ability of its lecturers, but also in its publishers. The two volumes on Evolution and Sociology, as well as The Evolutionist, which for the past year has constituted a modest bimonthly organ of the association, were published by James H. West, of Boston, whose single-hearted devotion to the work has not been excelled by that of the active members of the association. Since 1890 the lectures have been published by Messrs. D. Appleton & Company, of New York—the publishers of the works of Spencer, Huxley, Darwin, and other eminent scientific teachers of our time. They have met with cordial recognition from leading reviewers and scientific teachers, and are having a steady and constantly increasing sale. The aim of the association has been to combine a popular mode of presentation with scientific accuracy of treatment; and this end has been fairly achieved. Each lecture is submitted to criticism by competent invited speakers when delivered, so that inaccuracies, if they exist, are discovered and corrected, and both sides of all disputed topics are fairly presented. A full abstract of the discussion is published with the lectures, which greatly adds to their value in many instances for all who desire scientific accuracy and have faith that the truth is best discovered by the free use of the enlightened reason.

The membership of the Brooklyn Ethical Association, which has gradually grown from year to year with no backward steps, now includes between two and three hundred ladies and gentlemen, of whom more than two thirds are active members, resident in Brooklyn and New York. The remainder includes a number of non-resident associate members, whose homes are in different portions of the United States and England, and fifty-five corresponding members, comprising some of the best-known names of those eminent in science and literature the world over. Among those who have accepted membership in the association and expressed their cordial sympathy with its work are Mr. Herbert

* Corresponding members.

Spencer and Prof. Thomas H. Huxley, of London, England; Alfred Russel Wallace, D. C. L., LL. D., of Parkstone, Dorset, England, the co-discoverer with Darwin of the law of natural selection; Prof. William Graham, M. A., of Queens College, Belfast, Ireland, author of The Creed of Science, Social Problems, etc.; M. Th. Ribot, of Paris, France, editor of the Revue Philosophique, perhaps the most eminent advocate of the doctrine of evolution in that country; Count Goblet d'Alviella, of Brussels, Belgium, author of Evolution of Contemporary Religious Thought; Prof. Ernst Haeckel, of the University of Jena, Saxe-Weimar, Germany, author of The History of Creation, Evolution of Man, etc.; Prof. A. Hjalmar Edgren, Chancellor of the University of Gothenburg, Sweden; Baboo Pratapa Chandra Roy, translator of the Mahabhârata; and Baboo Amrita Lal Roy, editor of The Hindoo Magazine, Calcutta, India; and in our own country, Prof. Joseph Le Conte, LL. D., of the University of California, author of Evolution as related to Religious Thought, etc.; Prof. William Emmette Coleman, of San Francisco, member of the American Oriental Society; Prof. Edward D. Cope, Ph. D., of the University of Pennsylvania, author of Origin of the Fittest, etc.; Prof. Edward S. Morse, of the Peabody Institute, Salem, Mass.; Prof. John Fiske, of Cambridge, Mass., author of Cosmic Philosophy, etc.; Prof. Otis T. Mason, of the National Museum, Washington, D. C., President of the American Folk Lore Society; Prof. Amos G. Warner, Superintendent of Public Charities, Washington, D. C., recently elected to the chair of Economics in the Leland Stanford University, California; Rev. William J. Potter, of New Bedford, Mass., President of the Free Religious Association; Rev. Minot J. Savage, of Boston, author of the Evolution of Morality, etc.; Rev. E. P. Powell, of Clinton, N. Y., author of Our Heredity from God, etc.; Andrew Dickson White, LL. D., late President of Cornell University and United States Minister to Russia; Mr. Frederick May Holland, of Concord, Mass.; Mr. J. W. Alfred Cluett, of Troy, N. Y.; Rev. John C. Kimball, of Hartford, Conn., and others.

Though the association is perhaps best known for its advocacy of evolution views, its terms of membership are entirely undogmatic and unsectarian, being conditioned only by good moral character and a tacit pledge to the use of the scientific method in its investigations. Its constitution expressly declares that "membership in this association shall not be regarded as committing one to any particular form of religious belief, nor as interfering with other religious or secular connections. No doctrinal test shall ever be required as a condition of membership. Any person of good moral character, over eighteen years of age, approving the objects of the association, may become a member on recommendation of the Committee on Membership, duly reported to and approved by

the association." In order to popularize the conditions of membership the annual dues have been kept very low, being at present only two dollars per annum. The conditions for non-resident membership are similar to those for active membership, the dues being the same, and non-resident members being entitled to receive without further expense "publications of the association of a value not exceeding the annual membership fee." Corresponding membership, which does not involve any pecuniary obligation to the association, is bestowed on such persons in sympathy with its aims as the Board of Trustees may nominate and the association elect.

On the 5th day of February, 1891, the Brooklyn Ethical Association was duly incorporated under the laws of the State of New York, its objects being stated as follows:

"*a.* The scientific study of ethics, politics, economics, sociology, religion, and philosophy, and also of physics and biology as related thereto.

"*b.* The application of the results of such studies to the problems of practical philanthropy and statesmanship.

"*c.* The procurement, preparation, and delivery of popular lectures, expositions, and discussions, and the circulation of the same, together with other printed matter related to such subjects.

"*d.* The promotion of unity and harmony among the friends of progress by correspondence, friendly intercourse, and the application of the scientific method to social, religious, and political reforms.

"*e.* The maintenance of a library for the purpose of more effectually carrying out the objects of the association."

The association long since outgrew whatever theological limitation may have been presumably implied by its connection with a Unitarian society. Its membership now includes a minority of avowed Unitarians, together with orthodox Congregationalists, Episcopalians, Catholics, Friends, and people of other diverse religious connections, as well as agnostics and liberals of various stripes and degrees of belief or unbelief.

The success of the association in recent years and the extension of its work into new fields of practical investigation have been due in no small degree to the faith, wisdom, energy, and enthusiasm of Mr. James Avery Skilton, for three years its corresponding secretary and an untiring worker in its behalf. Mr. Skilton is a member of Plymouth Church, a graduate of the Rensselaer Polytechnic Institute of Troy, N. Y., and the Wesleyan University of Middletown, Conn., and with a thorough scientific education combines a large experience in practical affairs and long acquaintance and thorough sympathy with the doctrine of evolution as expounded by Mr. Spencer, Mr. Fiske, and its ablest advocates in

Europe and America. With a clear insight into the causes of social phenomena, he possesses great independence of mind and judgment. Though temporarily withdrawn from official connection with the association, he continues his membership, and is in thorough sympathy with its work and aims.

Mr. Herbert Spencer has manifested his sustained interest in the objects and work of the association by frequent correspondence and generous commendation of its efforts and accomplishments. After declining membership in the French Academy and the leading scientific bodies of Europe, he paid the Brooklyn Ethical Association the high compliment of accepting its corresponding membership. The cordial feeling on his part is heartily reciprocated by every member of the association, and it has fallen to the lot of some of its representatives to be honored by the privilege of defending Mr. Spencer against the unjust assaults of his critics on this side of the Atlantic. Happily, he has lived to see his great work almost accomplished, and its purport much better understood than it was two decades ago. Nowhere has it found firmer or more appreciative friends than in America. That the Ethical Association has been able in a modest way to take up and carry on the work of popularizing evolution views so ably begun by the founder of The Popular Science Monthly is not the least among the sources of congratulation in the judgment of its members.

To continue this work, and by means thereof to aid in the scientific solution of those vast and impending problems of our social and political life in the discussion of which, under the prevailing *a priori* and empirical methods, wisdom has often been obscured by a multitude of unscientific and conflicting counsels, is their continued ambition, and to this end they solicit the sympathy and co-operation of all consenting minds.

SEVERAL travelers in Africa remark upon the better condition of the negroes in proportion as they are remote from the white men. Mr. Alfred Coode Hone, in his book, Tanganyika, which records his eleven years' experiences in central Africa, says that along almost any section of the continent, from coast to center, "the farther the traveler advances into the interior, the better is the condition of the natives found to be; less drunkenness, less immorality, more industry and independence." Mr. Wilmot Brooke, says the London Spectator, writing of the west coast, tells us the same story, with a more severe reference to the exterior influences inimical to the African peoples. Describing the degradation of the coast tribes and its causes, he adds, "Last of all, they are dragged lower still by their contact with the white man." As he ascended the Niger, the squalid villages were seen no more; they were replaced by fine, clean, open towns, with thousands of inhabitants, and he entered a new world, physical, political, social, and religious.

NOTES ON PALÆOPATHOLOGY.

By R. W. SHUFELDT, M. D.

ANIMALS that lived during the past ages of the world, and now long since extinct, must have suffered, it would seem, from many injuries quite similar to those now sustained by their descendants of the present epoch. So far as the writer is aware, the discovery of the evidences of such conditions is of extremely rare occurrence, and the literature pertaining thereto practically a blank page.* Among fossil invertebrate remains I do not recall ever having either observed or heard of a single instance, although during geologic times many forms of the invertebrata must have perished when such parts of their economies as usually fossilize exhibited evidences of disease, and would thus be observed by the paleontologist when those specimens came to be discovered and examined.

With respect to the vertebrata, however, I have been somewhat more fortunate in this matter, as I can show in the course of the present article. Still, even among them one may examine many hundreds of specimens before he will meet with one of their fossilized bones which shows that it was diseased at the time of the death of its owner. It is one of the very rarest of things. In two or three different articles, several years ago and later, I published a number of instances where, in the preparation of the skeletons of existing birds, I had discovered a variety of pathological conditions of the bones.† Many, if not the majority of those cases, however, were the results of gunshot wounds, and, of course, it goes without saying that that class of injuries would not occur among fossils; and their very absence is one good reason for the greater rarity of examples of disease in the skeletons in these extinct forms, as one may easily imagine.

Several months ago Prof. E. D. Cope, of Philadelphia, placed in my hands for description some fifteen hundred specimens of fossil birds from the Pliocene of southwestern Oregon. Here then, indeed, was an excellent opportunity to investigate such a matter, for surely among several hundreds of bones we would be

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* Palæopathology (Greek παλαιός, ancient, and πάθος, a suffering), the word used in the title of this paper, is a term here proposed under which may be described all diseased or pathological conditions found fossilized in the remains of extinct or fossil animals.

† The following are the principal articles of mine on this subject: (1) Notes on a Few of the Diseases and Injuries in Birds, The American Naturalist, vol. xv, April, 1881, pp. 283–285; (2) Notes on the Diseases of Birds' Beaks, The Journal of Comparative Medicine and Surgery, vol. viii, No. 2, April, 1887, pp. 181, 182 (illustrated); (3) Examples of Fractures and their Union in the Bones of Birds, The New York Medical Journal, vol. xlviii, No. 26, New York, December 29, 1888, pp. 714, 715 (illustrated).

most likely to meet with at least a few specimens of a character to which reference has just been made.

These fossils were principally of water birds, having been discovered in the former bottoms of dried-up Tertiary alkali lakes, or upon the margins of those undergoing a similar process. With them were found immense numbers of arrow points of human manufacture, and the question had arisen as to whether it were not possible that they had been shot at the game during former times. To shed further light upon such an interesting subject, I most carefully examined each and all the specimens to discover if possible any healed wounds (fossilized) that may have been produced by such means. My interest in this matter was much stimulated by what Prof. Cope had formerly written in the American Naturalist for November, 1889. After describing the discovery of the bird-fossils referred to above, that eminent paleontologist there says that "scattered everywhere in the deposit were the obsidian implements of human manufacture. Some of these were of inferior, others of superior workmanship, and many of them were covered with a patine of no great thickness, which completely replaced the natural luster of the surface. Other specimens were as bright as when first made. The abundance of these flints was remarkable, and suggested that they had been shot at the game, both winged and otherwise, that had in former times frequented the lake. Their general absence from the soil of the surrounding region added strength to this supposition. Of course, it was impossible to prove the contemporaneity of the flints with animals with whose bones they were mingled, under the circumstances of the mobility of the stratum in which they all occurred. But had they been other than human flints, no question as to their contemporaneity would have arisen" (page 979).

Now, I found no fossilized injuries of the bones in question that could be attributed to wounds of them that arose from arrow-shot; but, on the other hand, one or two pathological conditions of interest were discovered, and one of these a fracture in the course of healing.

In order to make clear the stage at which this healing fracture existed at the time of the death of the individual that sustained it, I will first offer a few remarks upon the course of such injuries in existing animals.

Fractured extremities of bones in both mammals (not including man) and birds are rarely kept quiet and properly approximated during the healing process, which takes place at the fractured extremities. This results in the formation of a "provisional callus" which soon surrounds the broken ends of the bones, and acts as an osseous splint, that strengthens with time.

For the first week or more this exudation of reparative material takes place at the point of fracture—occurring externally between the periosteum and the bone, and internally between the medullary membrane and the bone. At the end of about three weeks this provisional callus acquires a firmness about equal to that of cartilage; which, at the end of three months, both internally and externally, ossifies—the ossification being more or less of a spongy nature. Shrinkage now takes place, and this spongy ossification becomes modeled down, forming compact bone. Still, at this stage the fractured ends are only united by fibrous tissue, though the surrounding ossified callus holds them firmly together.

Finally, this provisional callus undergoes more or less complete absorption, and the *permanent* callus forms directly between the fractured ends of the bone. This results in the nearly complete disappearance of the periosteal enlargement, and, internally, in the re-establishment of the medullary canal. Normally, this is the course of the union of fractures in long bones, of the character referred to above, but there are a number of exceptions to it, and irregular unions occur which do not require comment from me in the present connection.

Several years ago I obtained a turkey vulture (*Cathartes aura*) that had survived a glance shot from a carbine ball which fractured both bones of the left forearm of the upper extremity. It had also sustained other fractures, all of which I fully described in the New York Medical Journal (see No. 3 of foot-notes given *antea*). This bird I subsequently killed with chloroform and prepared its skeleton. Upon examination it was discovered that the left ulna and radius were each fractured at the points shown in the accompanying cut (Fig. 1),* and were at the time of its death at that stage of union where the provisional callus is well under way toward absorption.

From my various observations in such cases I have arrived at the conclusion that at this stage the *weakest* point in the provisional callus lies in the plane of the meeting of that material, as it is furnished by the two broken ends of the bone—in other words, it is at its *thickest* part and *in the plane of the fracture*. I mention this fact, as reference will soon be made to it again, further on.

Owing to the support afforded by the quill-butts of the secondary feathers of the wing in a bird, acting as a compound splint of Nature's furnishing, the radius and ulna in that class of verte-

* I am under obligations to the New York Medical Journal for the loan of the electro of this figure, and hereby tender my grateful acknowledgments for the same. The original was drawn by me direct from my specimen, a number of years ago, and I still possess the latter in my private cabinet.

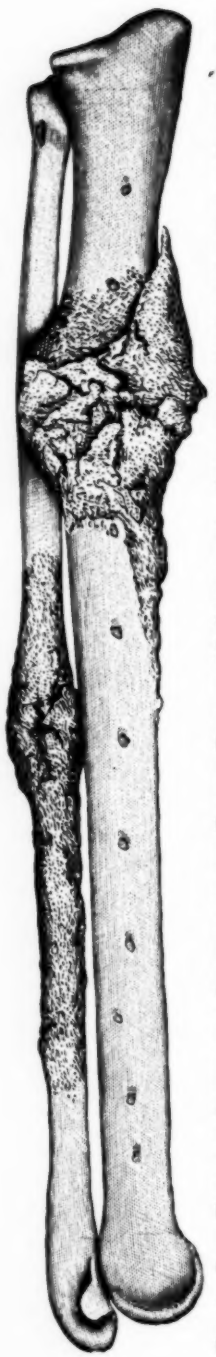

FIG. 1.—LEFT ULNA AND RADIUS OF A SPECIMEN OF THE TURKEY VULTURE (*Cathartes aura*). Outer aspect, showing union three weeks after fracture from a glance shot from a ·45 Government carbine ball. From the author's figure. (The larger bone is the ulna.)

brates usually unite with scarcely any deformity. This is by no means the case in mammals below man, for in them, where the long bones of the limbs are fractured near their middle, or even in the upper and lower thirds, very considerable angularity results upon union—an angularity that in some cases may even equal a right angle, as I once saw in the case of a fracture of the femur in a muskrat (*Fiber zibethicus*).

The specimen exhibiting the fracture in Prof. Cope's collection of fossil birds consists of a portion of some such bone as the humerus from a bird apparently about the size of a medium-sized goose. It is about 4·5 centimetres long, and has been broken longitudinally both through the callus and the shaft, the corresponding piece having been lost. If the piece be from the humerus of such a bird as I have mentioned, it must be from the very *middle* of the shaft, for it presents no part of the sigmoid curve as seen at either extremity. The walls are comparatively thin, and the medullary canal large. The fracture occurred square across, or at right angles to the axis of the shaft. There is no provisional callus within the medullary canal, but the bone in the neighborhood of the fracture within that tube is roughened, showing the effects of the attempt at repair. Probably the internal provisional callus may have been broken out of the specimen before it was discovered. Externally the fossilized, spongy, bony callus is quite abundant, and has all the appearance of the distal moiety of the callus upon the ulna of the turkey vulture shown in Fig. 1, and was at about that stage when the individual perished. Among existing birds of the group to which I suspect this specimen belonged, as the swans, geese, and ducks, I have known very excellent results follow in the case of the direct simple fracture of the shaft of the humerus. If they be not pursued to the death by the hunter, they usually swim

about on the water during the day, and feed along the shore or in the marshes at night, always holding the wing well up until the fracture unites. The case is different with land birds, where, in getting about, the seat of the break is often violently disturbed.

This interesting fossil specimen, then, goes to prove that the union of fractures of the shafts of the long bones in the vertebrata during the later Tertiary times was identical with what now occurs in the case of existing forms. Such a thing would be most naturally suspected, but, as with some of the simpler, self-evident theorems in geometry, it is invariably required that the *proof* be forthcoming. It is quite another thing to conjecture *how* this fracture came about. If I be right in my guess that the specimen was a bird, and that bird was a goose, why, it may have been done in battle with one of its own kind; it may have been done by a blow from a bird of prey, which afterward failed to secure the quarry.*

Such evidence as I possess upon the first-mentioned supposition is by no means to be implicitly relied upon; and in the case of the second supposition such a circumstance as is pointed at would certainly be one of the rarest occurrence.

The bone could much more easily have been broken by having been struck by an arrow by its flint-pointed head, provided it were shot with sufficient strength from a bow. Of the probability of that I leave the reader to judge for himself; there is some evidence to sustain such a conjecture, no inconsiderable part of which has been presented above, and more can easily be found between the lines.

I pass now to the consideration of one other pathological condition pre-

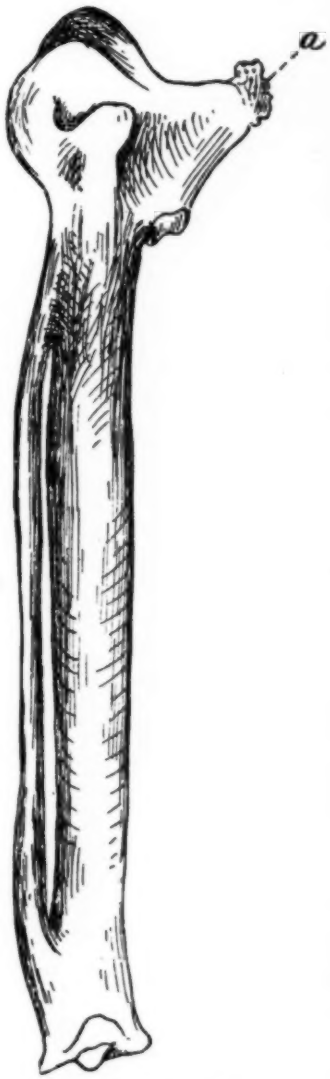

FIG. 2.—LEFT CARPO-METACARPUS FROM THE HAND OF AN EXTINCT SWAN (*Olor paloregonus*) FROM OREGON. Outer aspect and natural size from the specimen by the author. *a*, the seat of the disease on the summit of the first metacarpal.

* In the collection I discovered the remains of two new species of extinct eagles.

sented on the part of the bones of the fossil birds in Prof. Cope's collection. It occurred only in specimens of swans, geese, and ducks, and consisted in a more or less abundant exudation of spongy, osseous material that appeared upon the proximal part of the first or pollex metacarpal of the carpo-metacarpus (Fig. 2, *a*). It was present in a good many specimens of all the families enumerated above; it was entirely absent in a lesser number of specimens of two or three of the same groups. It would seem to me that such a condition could only be brought about by some blow or other given at the point in question, which point is one in the wing of those birds that is quite superficial, in so far as the bone is concerned, and might, upon receiving a square rap of sufficient force, injure its periosteum to such an extent as to have a subsequent osseous exudation result there. The vast majority of those fossil anserine birds of that region were identical with those species now in existence in our avifauna, and, it is but fair to presume, possessed habits similar to them. Yet in *Pliocene* time they may all have had some different habits: it occurred to me that they may have fought each other with their *wings*—or, may be, fought some common enemy as yet unknown to us. The fossil bones exhibiting this disease may have belonged only to the males, and they may have fought during the breeding season; or it may have occurred only in the females, who for some reason may have been called upon to fight with their wings in defense of their young. Some *existing* birds have large *spurs* upon certain bones of their hands, and they are known to fight with their wings at the present time; but in some future epoch, if the descendants of those forms persist, the necessity for such an armature may pass away, and with it the spurs themselves. Modern swans are known to strike a blow with their wings in defending themselves or their young. With these thoughts in my mind I asked Prof. Cope for his opinion in the premises, and, without hesitation or hint from me as to my own musings, he answered, "Why, possibly, they fought each other with their wings." I have never observed any similar pathological condition in our modern *Anseres*, and I have both made and examined skeletons of a great many of them.

A DANISH archæologist, G. V. Smith, has been experimenting upon the practicability of using the simpler forms of flint implements for working in wood. He fitted handles of various forms to the flints and worked with them on pine with complete success. He was in some cases convinced that the same flint hatchet would serve equally well for working harder wood than pine. With these primitive tools it would be possible to bring down large trees and execute all kinds of simple carpentry work.

THE SCHEELE MONUMENT AT STOCKHOLM.

By FRED. HOFFMANN.

ON the first day of August, 1874, the chemists of Great Britain dedicated a monument to the British discoverer of oxygen. On the same day a large number of American chemists assembled at the beautifully located village of Northumberland at the junction of the two branches of the Susquehanna River, in order also to pay homage to the memory of that remarkable theologian, philosopher, and naturalist, Joseph Priestley, who lived and died in that quiet Pennsylvanian village. In the orations delivered at this occasion of the centennial of the discovery of oxygen, the element which for the following half century became the cornerstone for the structure of a new chemical philosophy, equal justice was done, especially by the late Prof. Sterry Hunt and Prof. Lawrence Smith, to both discoverers of oxygen, Priestley and Scheele. Both men, though of different caliber and station in life and searching in different directions, recognized almost at the same time and independently of each other the nature of oxygen, and to a large extent also the important part which this element plays in the commonest chemical processes and changes of matter. Yet both, skilled and ingenious experimentalists though they were, and Scheele keen and discerning in deduction and application, prepossessed by the doctrine of Stahl, then prevalent and apparently settled, missed the real bearing and ultimate consequence of their discovery, and died defenders of the theory of phlogiston—the very men who furnished the facts and the weapons with which that hypothesis was shattered a few years afterward by Lavoisier, and a new system of chemical philosphy was established.

The memory of these three contemporary representative investigators of the three foremost nations of their time—England, Germany (Scheele was a German by nationality, born in Pomerania, then under Swedish rule), and France—has ever since been honored. Monuments have been erected to Lavoisier in Paris, to Priestley in Birmingham (1874), and to Scheele in Köping (1827). Scheele especially has repeatedly been remembered by his grateful adoptive country, Sweden. In 1790, four years after his death, the Academy of Sciences in Stockholm, of which he had been a member, had a medal struck to his memory. It contained on one side his portrait in relief, and on the other a symbolic representation of the discovery of oxygen, and the inscription, "*Ingenio stat sine morte decus*" (the beauty of his genius stands immortal). In 1827 the Academy had a second medal struck, with Scheele's portrait, and on the other side the veiled

figure of Isis with Hermes lifting the veil, and the inscription, "*Naturæ sacra orgia movit*" (he stirred the holy mysteries of Nature). In the same year the Apothecaries' Society of Sweden erected a monument with a relief portrait of Scheele in the Lutheran church in Köping, of which Scheele had been a member.

At the occasion of the centennial of Scheele's death, May 21, 1886, a memorial service was held at Köping, where Prof. Bergstrand, of Stockholm, delivered an oration on the life and life-work of the eminent apothecary and chemist. On this occasion the project was advanced to erect to Scheele a monument at Stockholm similar to the one that had been placed there to Berze-

lius in 1855. The Apothecaries' Society of Stockholm fostered this project in close accord with the learned societies of the country, and with so much success that the requisite funds were soon raised. A committee, with Prof. von Nordenskjöld at its head, took charge of the matter. Prof. I. Börgeson, the eminent Swedish sculptor, undertook the modeling of the statue, and has executed a fine work of art. The statue, which represents the chemist resting on a chair and watching a process of ignition in a crucible, was unveiled on the 9th of December, 1892, the one hundred and fiftieth anniversary of Scheele's birth. It stands in the "Humble Garden," one of the city parks, upon a beautiful floral par-

terre near the monument of Linné, erected in 1885. The unveiling took place in the presence of King Oscar of Sweden, all the royal princes, the ministers of state, the invited descendants of the Scheele family, and of numerous representatives of the state and city governments, of the universities and the learned societies of the country. Prof. von Nordenskjöld delivered a brief dedication oration, and numerous wreaths of flowers were deposited at the base of the monument as offerings from the institutions and societies represented by delegates. This ceremony being over, a state banquet took place, at which Prof. P. T. Cleve, of Upsala, the biographer of Scheele, delivered a brief oration; and Prof. Retzius, of Stockholm, Prof. Waage, of Christiania, Prof. Curman, of Stockholm, and apothecary William Sebald addressed the assemblage. A large number of congratulatory telegrams and messages from learned societies and eminent scholars from Sweden, and from Berlin, Vienna, St. Petersburg, Copenhagen, Paris, and other cities were received and read.

In the evening the Apothecaries' Society of Stockholm gave a banquet to about two hundred and fifty invited guests. Apothecary I. Nordin delivered the oration on Scheele as an apothecary and chemist. Prof. Stahre, of the Pharmaceutical Institute of Stockholm, communicated the thanks of the society to the chairman of the Scheele committee, Prof. von Nordenskjöld, as well as to the sculptor, Prof. Börgeson, and presented them with the first copies of a Scheele medal, struck for this occasion in silver and in aluminum. This medal bears a relief portrait of Scheele with this inscription: "Carolo Guilmo Scheele, *pharmaceutæ chemico grati cultores Ordo Pharmaceut. Suecia*" (the Swedish order of pharmacists, grateful cultivators of their art, to Charles William Scheele, the chemist). On the other side is a representation of Scheele's house and pharmacy in Köping, with the inscription, "*Domestici parietes ipsum, non famam continuerunt*" (the walls of his house could not contain his fame).

Besides notices in larger chemical and historical works, brief biographies of Scheele have been published at different times, mostly in Germany, and especially at the occasion of the celebration in 1886, but only a few in England and America. Of the more recent ones are those by Prof. P. T. Cleve in Upsala, and by Prof. F. A. Flückiger in Strasburg,* and a brief sketch in Vol. XXXI, pages 839–844, of The Popular Science Monthly.

Scheele's writings, all in German,† of which the treatise on

* Reprinted in vol. iv, pp. 188 and 208, of Pharmaceut. Rundschau, New York.

† Although living more than half his life in Sweden, Scheele remained so much a German that his knowledge of the Swedish language was imperfect; his essays addressed to the Academies of Stockholm and Upsala, as well as his correspondence, were all written in German.

Air and Fire, written in 1775, is the most remarkable one, were collected and published in 1793. His contributions to the Academy of Sciences in Stockholm have been issued in an English translation by Thomas Beddoes. Prof. von Nordenskjöld prepared for the recent celebration a complete collection of Scheele's scientific notes and of his letters to eminent contemporaries, which has just been issued in a Swedish and a German edition.* This voluminous and splendidly prepared work is an important supplement to all former publications of Scheele's writings and the several historical sketches of his life and labors, and is of paramount value to every student of the history of chemistry. From among the many interesting new facts brought to light in it are: Scheele obtained and recognized oxygen (fire-air) as early as in 1765 in connection with his researches of nitrous acid. Before the year 1771 he obtained oxygen in various ways by heating silver and mercury carbonates, silver and gold oxides, alkaline nitrates, arsenic acid, and black oxide of manganese. He therefore *obtained and recognized oxygen several years before Priestley's independent discovery of it.* At about the same time he obtained and recognized nitrogen, hydrogen sulphide, hydrogen chloride, ammonia, and nitrogen dioxide gases. He knew before 1772 the color reaction of the blowpipe flame with potassium and sodium compounds, and made use of them, as also the methods of separating iron from manganese by means of acetic acid. He was also familiar with the transformation of insoluble silicates into soluble ones by fusing them with alkalies.

Scheele's letters and laboratory notes just published by Prof. von Nordenskjöld bear evidence of his advanced knowledge in most departments of chemistry, and of the unusually large number of his researches, observations, and exact discernment in his numberless experiments and deductions. The book abounds in novel views and facts relative to the interesting period of the transformation from the phlogiston epoch to the modern doctrines of chemical philosophy and application. It furthermore bears ample evidence of the fundamental influence and part which Scheele's labors and ingenuity have had in preparing and clearing the domain of chemistry for Lavoisier's subsequent theoretical consummation.

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* Carl Wilhelm Scheele. Nachgelassene Briefe und Aufzeichnungen. Herausgegeben von A. E. Nordenskjöld. One large octavo volume, pp. 506, with illustrations and *fac simile* letters. Stockholm, 1892. This work is published by subscription only, and according to order the German or Swedish edition will be sent postpaid by mail on receipt of five dollars paid by international money order addressed to Dr. E. Svedmark, Geological Survey, Stockholm, Sweden.

EAST CENTRAL AFRICAN CUSTOMS.

By JAMES MACDONALD.

PART I.

THE following account of a few of the customs common among the tribes of east central Africa, in the region of Lake Nyassa, has been gathered from many sources; most of the statements have been revised and corrected by missionaries and others who have, during the past twelve years, been resident in the lake region.

As early as 1586, Don Santos, writing of the natives of eastern Africa, inclines to the belief that they once were acquainted with true religion, and that they had degenerated to such a degree that it, and all idea of a former civilization, had been entirely lost. This opinion he based upon the existence among them of trial by ordeal, which he regarded as having its origin in Scripture, and that from this source they must have first obtained it. The worthy Portuguese, had he lived in our day, would hardly have attributed customs, dating perhaps thousands of years before the Exodus, to the Mosaic legislation. One fact he does record which is of deep interest, if his account can be fully relied upon, and that is, that near Tetė, on the Zambezi, men and women were confined in regular pens like cattle, and slaughtered for food as required. These were prisoners taken in war, and who could not, there being a large number, be "used up at once."

Of all central African customs trial by ordeal, which is universal, is that which is most revolting to a European brought for the first time into contact with savage life. When a man is accused of any crime, as theft, arson, murder, witchcraft, or the like, evidence is brought against him in the way common throughout the whole continent. This, however, is never final. The accuser's witnesses swear to anything required of them without the slightest compunction of conscience, and as the prosecutor must produce his evidence first, the defendant's witnesses are ready to swear, and do swear, the opposite of all that has been said. Trial is invariably in open court, and nothing said by the witnesses for the prosecution can be concealed from those that are to follow. There are no affidavits, thus making contradiction at once simple and safe. If rebutting evidence were allowed, the most paltry trial would be interminable. For a witness to be called a liar is, in such a case, a compliment. It proves that his evidence told, and that he, by inference, is a very clever fellow. If the same man were accused of bewitching he would regard it as a foul libel and demand the poison bowl without an hour's delay.

To remedy the defects of trial in court, that by ordeal is

adopted in all kinds of causes, both civil and criminal. As the case proceeds before the council, the accused at intervals demands the *mwai*, and this demand his friends, if they believe him innocent, persistently press. The accuser resists the demand as unnecessary, knowing that should the culprit, even if caught red-handed, recover, he will be placed in a difficult position. He will in that case have no claim to compensation for an injury, and may in turn be successfully sued for willfully seeking to destroy another man's reputation. The belief in the absolute certainty of trial by *mwai* is universal, and the beginning and end of reasoning is thus: "If he is guilty, he dies; if he does not die, should the stolen property be found on his person, he is not guilty; another put it there, or he was bewitched."

The life of an African properly begins at puberty. Then he is no longer a child, and discards both the work and amusements of boyhood. There is no great difference between the customs in central Africa and those in the south as regards infancy and childhood.* The seclusion of the mother, purification by the magician, sacrifice to ancestral spirits, wearing of charms to ward off evil and to promote growth and strength, are all customs with which we are familiar among the better known tribes bordering on the Cape Colony. In the lake region the rites of initiation into manhood do differ considerably, but as this is a subject which has not been very fully investigated, what follows is in a measure tentative. The rite of circumcision is general, and, though many observers trace this to Arab influence, there seems no sufficient warrant for the assumption. Few, if any, Arab habits have been universally adopted, and why this one rather than others? At circumcision it is customary to isolate the neophytes and treat them generally as is done by Zulus and Kaffirs, the close of the ceremonies being marked by dancing, feasting, and riot. The young men have arms put into their hands and are harangued by the elders, bards, and magicians. They are now men and men's work is to be theirs. Herding, hoeing, reaping, and all domestic duties in which they assisted their mothers, they have no longer any concern with. War, hunting, and hearing causes must now occupy their thoughts, for they are to take the place of the fathers, and on them will depend the defense of the tribe and the maintaining of its honor. They must defend their chief, avenge his wrongs, wage war at his word, and obey his commands if that should imply death; "a man can die but once," with which philosophy they are launched into the new life of full manhood.

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* The Yao, Makololo, Makuas, Machingas, Angoni, and many other tribes observe substantially the same customs at birth and during childhood.

Young women are initiated into the mysteries,* as the ceremonies are called, by rites and ceremonies nearly akin to *intongane* in the south, and are then taught, in actual fact and by experience, much that would be regarded as immoral and not to be named among Western nations. The details of these ceremonies I have not been able to obtain and verify with that degree of accuracy that would justify publication, as it might tend to mislead and confuse. One thing is certain, that in the case of both young men and women separating into pairs with persons of the opposite sex is deemed essential. If this were neglected in the case of girls after the establishment of the menstrual function, they would die. There is a second ceremony when a woman is for the first time *enceinte*. Her friends gather and make preparations as for a marriage feast; her head is shaved; the matrons in attendance sing songs and give the neophyte much advice, finishing with a glorious revel at night.

Taking the people as the traveler meets with them, the first thing to be studied is village life and personal rights and liberties. From that we may conveniently advance to the study of tribal life and national institutions. When a Yao or Wanyasa leaves his home to form a new village, he wishes to strengthen his position by every means at his command. This he can do in several different ways. Free men may be induced to join him and form the nucleus of the proposed settlement; he may purchase slaves and many slave wives, or, if able, make a raid and capture slaves to do the work necessary during the initial stages. When the village is recognized by the chief, it becomes subject to the general laws of the territory. There is the same council, presided over by the new headman; the same intercourse between the headman and chief by special "messengers"—that is to say, confidential advisers; the same system of land distribution and tenure, with the yearly tribute, as in older settlements. Petty cases are tried by the headman, graver cases are reserved for the hearing of the council. The head of a village may, under African law, kill his slave,† but only a fool would do so, as he would simply impoverish himself by the value of his chattel in the open market. Besides, should a man kill a slave unjustly, he himself would "wither away and lose his eyesight." Domestic slaves have a *quasi* right to any property they may accumulate while they remain with the master under whom they gather it, but if sold the property remains the master's. Most Africans like to see their slaves become rich. "Are they not," say they, "our own

* Wanyasa—south end Lake Nyassa ceremonies. Boys do not pass through them, but Yao, Makua, and Angoni boys do.

† Yao, Anyasa, Awisa, etc.

children?" When the Fingoes left the Gcalekas, whose slaves they were, to come under British rule, they brought with them numerous droves of cattle which they were allowed to possess in the land of their captivity. A slave's wives and children belong to his master and may be sold at any time. A headman who is in debt* sells first his slaves, then his sisters, next his mother, and finally his free wives, after which he resembles the proverbial Highlander; there is nothing more of which he can be stripped.

Closely connected with personal rights and liberty is the law of inheritance.† A man's heir is his brother, the son of his mother, failing that, his sister's son; his own children are excluded. This, as will be easily understood, is to make perfectly sure, in a land where every married woman has a lover, that the heir has the family blood in his veins. The succession to the chieftainship is based on the same principle, which is curious, considering the terrible severity with which known cases of adultery, in the case of chiefs' wives, are punished. A man succeeds to his deceased relative's wives as well as to his property and rights; they are a part of the estate. And here it may be mentioned that wives are obtained by inheritance, by purchase as slaves, by presentation, or by raiding and theft. Generally one wife only is free. An infant a few days old may be bought and betrothed, or even an unborn child, conditionally of course. In the case of infant betrothal the suitor provides her with clothes, which is the token of his pledge.

At an African village the work is done chiefly by the women;‡ they hoe the fields, sow the seed, and reap the harvest. To them, too, falls all the labor of house-building, grinding corn, brewing beer, cooking, washing, and caring for almost all the material interests of the community. The men tend the cattle, hunt, go to war, and, curiously enough, do all the sewing required on their own and the women's garments. Neater tailors than Africans it would be impossible to find anywhere. By means of an awl and tendons from animals of the chase they can sew small squares of skin together so as almost to defy an expert to find a seam without looking at the reverse side, nor are they mean artists as regards cut and fit according to African notions. Whether they would satisfy those who wear only "tailor-made gowns," is a question which the ethnologist is not called upon to solve.

The African can not always remain at his own village; he may be called upon to undertake a journey on his own account, or at the behest of his chief, and in either case it is necessary to take

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* Notably among the Yao.

† Yao, Malemya's people at Zomba, Machingas, and many others.

‡ This is universal.

precautions to insure success. There are places in Africa where three men can not be sent on a journey together for fear two of them may combine and sell the third. But that by the way. When a man has determined on a journey he must consult the oracle by means of divination. The methods most commonly employed are as follows: The magician takes a quantity of flour and lets it fall in a steady stream on a flat stone placed at the head of the traveler's bed. If it forms a perfect cone as it falls, the omen is good; if not, there is an end of the matter at that time and by means of the flour cone. Sacrifice must now be offered to propitiate the offended spirits. When the cone is perfect it is covered by an inverted pot and left for the night. In the morning the pot is removed and the cone examined; if it is still whole and in the exact state in which it was left when covered, there is nothing further to be done beyond presenting a thank-offering of rice, flour, or fowl to the ancestral spirits and set out on the journey. Should there be a falling of the cone, even a small slip down its side, it is a sign not to be disregarded, and the oracle, after propitiatory sacrifice, must once more be consulted. The flour cone is now abandoned. The magician takes a pot of beer which he pours out upon the ground. If it sinks in one spot the gods are propitious, but should it run along the ground their faces are averted in anger or grief.

Another common method of divination is by means of small stones, claws, teeth, bits of snake-skin, and other odds and ends which the magician keeps in a calabash or gourd, and which are shaken to be thrown as is done with dice. He examines the position in which the contents fall, and as claws, teeth, or stones are to right or left he gives his responses, always with Delphic ambiguity. It is not necessary to have a magician present in order to consult the oracle, though this is desirable. The recognized diviners sell bits of prepared root which travelers carry. These, three in number, are in cases of difficulty placed upon the ground, two side by side, and the third across those lying parallel. The owner, after placing them in position, retires, and after an interval of some hours returns to examine them and learn the response. If they are in the position in which he left them, the oracle is favorable; if not, the reverse.

But even after the responses have been favorable and the sacrifices and offerings made, the departure of the travelers may be delayed. Should the leader, during the first day's march, hurt his toe against root or stump, they must return and begin the process of divination *de novo*. A rabbit crossing the road they are following denotes the death of the leader should they persist in the enterprise. A certain species of snake found on the path bodes evil to the whole party. When fairly on the road they

must observe certain time-honored customs. They must not use salt; if they did, and their wives were not behaving in their absence, the salt would act as a corrosive poison of the most virulent kind. Few Africans would take this risk.

The magician is in requisition in connection with every detail of life. In a case of illness an offering of flour is made to the ancestors. This is placed by the patient's pillow,* where the spirits come to regale themselves with its essence. If there is no improvement the magician is called, who may simply direct the patient to change his residence for a time and then take his departure. At other times he practices the art of cupping by means of an inverted horn, in which case he professes to "extract" the disease, as is done in the south, in form of bug or beetle. Counter-irritation, by means of incisions, into which ashes and pounded roots are well rubbed, is termed "killing" the disease. A charm may be given which the patient must wear as a means of cure and as a talisman against evil.

By far the most common method of cure is "smelling out" the person bewitching the patient by means of sorcery, and this is done both in cases of protracted illness and when a person dies suddenly.† The magician may simply "mark" the person who is causing the disease, who at once goes with a present to the sick man and a fee to the magician. It is, however, much more common to find the wizard put to death as a *sacrifice*,‡ and in this the custom differs from that observed in the south. There the culprit is always put to death as a *criminal*, and only after a tribal council has met and heard him "named" in the most formal manner. In central Africa the magician has the power of summary condemnation, when execution may follow immediately. The custom of human sacrifice accounts for the difference where, on the whole, the customs are the same, and regulated by the same usages. Any one may be accused of bewitching, and in the case of sudden death a traveler as readily as a resident. Dr. Elmslie, while traveling among the Angoni a year or two ago, came to a village where he halted for the night. He had three days of forest travel before he could reach the next settlement. The morning of his intended departure threatened rain, and his men, as always happens in such circumstances, were determined not to move. Again and again he tried to get them together, but without success. When he was about to give the case up as hopeless, a wailing and howling was set up in one of the houses and taken up by the villagers in chorus. His men came flying to their loads, which they picked up and struck into the path, adjuring him by

* Yao, as observed by Rev. Duff Macdonald. † Angoni, Notes by Dr. Elmslie.
‡ Rev. Duff Macdonald, Nyassa Region.

all the gods they knew to follow instanter, as some one had died and they might be accused of bewitching. The doctor followed, nothing loath to get on the road so easily.

The magician, when answering questions, shakes his gourd and examines the claws, teeth, and pebbles it contains.* From these he receives his oracles, and according to their position his answers are satisfactory or the reverse, but generally shrewd advice if somewhat ambiguous. It is they who prepare war medicine and doctor soldiers for the field; they, too, prepare the poison bowl and administer it to those who are to be tried by that means. At births, deaths, and marriages they are in constant attendance, and, while the chief derives his revenue largely from voluntary gifts, the magicians receive fees which are rigidly exacted.—*Journal of the Anthropological Institute.*

SKETCH OF ROBERT HARE.

THE name of Robert Hare, said the American Journal of Science at the time of his death, "has for more than half a century been familiar to men of science as a chemical philosopher, and to the cultivators of the useful arts throughout the civilized world." Dr. Hare was born in Philadelphia, January 17, 1781, and died in the same place, May 15, 1858. His father, the proprietor of a large brewery in Philadelphia, was an Englishman of strong mind, occupying a prominent position in society, and enjoying the confidence of his fellow-citizens. The management of this concern shortly fell into the hands of the son. He was soon drawn away from it, however, by the strength of his predilection for scientific pursuits; and before he was twenty years old he was enrolled as an attendant of the course of lectures on chemistry and physics in Philadelphia, and became a member of the Chemical Society of that city. There he found Priestley, Sybert, and Woodhouse among his associates. To this society he communicated in 1801 a description of the oxyhydrogen blowpipe, which was then called the hydrostatic blowpipe, and which Prof. Silliman, who had been engaged with him in 1802 and 1803 in a series of experiments with the instrument, afterward called the compound blowpipe. On his return from Philadelphia, in 1803, Prof. Silliman constructed for Yale College the first pneumatic trough combining Dr. Hare's invention; an apparatus which was afterward figured and described by Dr. Hare in his memoir on the Fusion of Strontia and the Volatilization of Platinum—a paper which was republished in London and in the

* Auyasa, Yao, Mauganga, Wanasomba, etc.

Annales de Chimie. This apparatus, according to Prof. Silliman, was the earliest and most remarkable of Dr. Hare's original contributions to science. It revealed to the chemical student a source of artificial power far transcending anything he had ever known before; and this, though the facts on which it was based were not unknown.

Lavoisier had directed a jet of oxygen on charcoal and had burned the elements of water together; but even he, and in the face of these experiments, had failed to comprehend the power of this heating apparatus, and it was left for the acumen of Hare to demonstrate it and make it practically applicable. The author of the biography in the American Journal of Science says of it, "In our view, Dr. Hare's merit as a scientific philosopher is more clearly established upon this discovery than upon any other of the numerous contributions he has made to science." Dr. Hare's original experiments were repeated in 1802 and 1803 in the presence of Dr. Priestley and Messrs. Silliman, Woodhouse, and others. In recognition of the discovery, Dr. Hare received the Rumford medal from the American Academy of Science at Boston. An attempt was afterward made, in 1819, by Dr. Clarke, of Edinburgh, to rob him of the credit of this discovery; and though he showed that the oxyhydrogen apparatus had been before the public several years, no attention was paid to his protests. The calcium and Drummond lights also furnish instances of most important applications of Dr. Hare's invention, in which no reference is made to him. He himself led the way to these devices by constructing an apparatus on a gigantic scale, with large vessels of wrought iron, capable of sustaining the pressure of the Fairmount Water Works, with which he was able to fuse at one operation nearly two pounds of platinum, with a resultant production of metal greatly purified.

He devoted much labor and skill to the construction of new and improved forms of the voltaic pile; "and it is easy to show," Prof. Silliman says, "that owing to his zeal and skill in this department of physics American chemists were enabled to employ with distinguished success, the intense powers of extended series of voltaic couples long in advance of the general use of similar contrivances in Europe."

In 1816 Dr. Hare constructed an instrument called the calorimeter, in which great extent of surface was obtained by combining many large plates of zinc and copper into one series, and plunging the whole at once into a tank of dilute acid. Great magnetic and heating effects were obtained with this instrument, and it was many years before any other voltaic apparatus was constructed in which the movement of so great a volume of heat was attained with so low a projectile or intensive force. By it large rods of iron or platinum were ignited and fused with splendid ex-

hibitions, while the intensity of the current was so low that hardly a visible spark could be made to pass by it through poles of carbon. The magnetic effects were afterward shown by Prof. Henry to be attainable from a single cell, if combined with suitable conductors. Instead of Cruikshank's cumbrous battery of alternating zinc and copper plates, which Davy used in the experiments that resulted in the discovery of the metallic bases of the alkalies, Hare found a way of obtaining a corresponding amount of surface and its resultant power with a single roll of metal, and in 1820 introduced the deflagrator, in which any series, however extended, could be instantaneously brought into action or rendered passive, at pleasure. This apparatus consists of a large sheet of copper having several hundred square feet of surface and a similar one of zinc, separated by a piece of felt or cloth saturated with acidulated water, and then rolled up in the form of a cylinder. Faraday bore testimony, in his Experimental Researches, to the merit of this invention when, in 1835, he acknowledged that, having worked exhaustively to perfect the voltaic battery, finding that Hare had anticipated him many years before, and had accomplished all that he had attempted, he at once adopted his instruments, as embodying the best results then possible.

With one of Hare's deflagrators, Prof. Silliman, in 1823, first demonstrated the volatilization and fusion of carbon, a result then considered so extraordinary that it was a considerable time before it was fully credited. It was with these batteries that the first application of voltaic electricity to blasting under water was made in 1831 in experiments conducted under Dr. Hare's direction.

Dr. Hare was also distinguished in chemistry as the author of a process for denarcotizing laudanum, and of a method for detecting minute quantities of opium in solution. He was interested, too, in the discussions of philosophical chemistry, as was most notably shown in the earnestness with which he contested what he conceived were the errors of the salt radical theory.

He made studies in meteorology, and had a theory of whirlwinds and storms founded on an electrical hypothesis, which he opposed to the rotary theory of W. C. Redfield. At the second meeting of the American Association for the Advancement of Science he explained his own views on this subject, while he controverted those of Mr. Redfield. This gentleman was present and heard his remarks, but made no reply then. He was not a speaker, and did not address the public except in writing.

In 1818 Dr. Hare was chosen Professor of Chemistry and Natural Philosophy in William and Mary College, and in the same year was made Professor of Chemistry in the medical department of the University of Pennsylvania. He held the latter position till 1847. His teachings were marked by the originality of his

experiments and the extent and variety of the apparatus he employed. He spared no labor or expense in his operations, and, being a handy mechanician, he was able to bestow much ingenuity in the construction of novel devices for experiment and illustration. He accumulated instruments and material with astonishing profusion. To these he added graphic illustrations and lucid descriptions to make his lectures intelligible and interesting. When he resigned his professorship, he gave all the apparatus he had accumulated to the Smithsonian Institution.

He was a man of literary tastes, fond of poetry, and himself wrote verses occasionally. He also sometimes wrote articles on the political and financial questions of the day, and contributed moral essays to the Portfolio, under the signature of "Eldred Grayson."

In person he had a robust frame, a large head, and an imposing figure and presence.

In his family and among his friends, according to Prof. Silliman, he was very kind, and his feelings were generous, amiable, and genial; yet, in the absence of mind occasioned by his habitual abstraction, and when absorbed in thought, his manner was occasionally abrupt. With his keen and active mind, conversation would sometimes seem to awaken him from an intellectual reverie. He had great colloquial powers, but to give them full effect it was necessary that they should be aroused by a great and interesting subject, and the effect was heightened by the injection of antagonism. He would then discourse with commanding ability, and his hearers were generally as ready to listen as he to speak. He was a man of unbounded rectitude, a faithful friend, and a lover of his country and its best interests, without thought of personal emolument or political advancement. He was a voluminous scientific writer. For many years his contributions to the American Journal of Science were more numerous than those of any other correspondent. The full list of them includes about one hundred and fifty articles, in forty-eight volumes of that journal, the record of the titles of which occupies five columns in the General Index of the first fifty volumes. Besides notices of the various substances he discovered or experimented with, and descriptions of apparatus, we find among these articles some that touch the principles of chemical and physical philosophy—as on the nature of acids and salts; concerning Faraday's views on atoms; on chemical nomenclature, a subject which is also discussed in a letter to Berzelius; on some inferences from the phenomena of the spark in Thompson's work on heat and electricity; on the error that electric machines must communicate with the earth; on a new theory of galvanism; on the cause of heat: a reply to Prof. D. Olmsted's views on the materiality of heat;

Reply to Matter is Heavy, as demonstrated by W. Whewell; on meteorological topics—storms of the Atlantic coast; reviews of Redfield's theory of storms and of Dove's essay on storms; an account of a storm or tornado in Rhode Island, August, 1838, "and others"; on Causes of Storm, Tornado, and Water-spout; among accounts of experiments and new methods—blasting rocks by galvanic ignition; apparatus for producing ebullition by cold; process for fulminating powder, consisting of cyanogen and calcium; mode of obtaining the specific gravity of gases; analysis of gaseous mixtures; method of dividing glass by friction; and apparatus for decomposition and recomposition of water. He was also author of a Brief View of the Policy and Resources of the United States (1810); Chemical Apparatus and Manipulations (1836); Compendium of the Course of Chemical Instruction in the Medical Department of the University of Pennsylvania (1840); Memoir on the Explosiveness of Niter (1850); and Spiritualism Scientifically Demonstrated (1855).

He was a member of the American Academy of Arts and Sciences and of the American Philosophical Society, and was one of the few life-members of the Smithsonian Institution.

In his geological explorations of the basin of the Red River of the North through six seasons, Mr. Warren Upham has paid careful attention to the geographic limits and relative abundance of both native and introduced plants. "It has been interesting," he says, "to find there the intermingling and the boundaries of species whose principal homes, or geographic range, lie respectively in the direction of the four cardinal points, east and west, and south and north." After describing this diversified vegetation in detail, the author concludes that besides the greater part of our flora which is of northern origin, coming to us from an ancestral flora that probably in the beginning of the Quaternary period occupied continuous land around the globe in high northern latitudes, the plants of the Red River basin include many species derived, as Gray and Watson have shown for a large portion of the flora of California, the Great Basin, and the southern Rocky Mountain region, from the plateau vegetation of Mexico. By the return of a warmer and drier climate in the southwestern United States, following the Ice age of the North, our cactus species, petalostemons, and onagraceæ, many of our compositæ, the milkweeds, and many more, have been enabled to spread from their original Southwestern and Mexican home-land, becoming a most important element of the flora of all the plains and prairie region to the Saskatchewan and Red Rivers, and gaining a less numerous representation in the wooded country east to the Atlantic coast. How these Northern and Southwestern floras have become intermingled, the geographic limits of separate species, and the gradual changes observable in the specific characters of some of our plants in passing between distant parts of their range, are themes of sufficient interest to repay the careful observations of amateur botanists in all parts of our country. In these directions important additions to botanic science may be made by many who have neither leisure nor ability for valuable biologic study of plants, but who love the search for wild flowers.

CORRESPONDENCE.

RECENT GLACIAL RESEARCHES IN ENGLAND.

THOSE readers of the Monthly who may be interested in the subject of glacial geology will recall a brief sketch of recent glacial discovery in England published in the December number. The article included a map of the glaciated areas of Great Britain and Ireland, prepared for Prof. G. F. Wright's new book, Man and the Ice Age, by Prof. Percy F. Kendall, of Leeds, England. We have, since the article was published, received a letter from Mrs. H. Carvill Lewis, calling attention to "a few slight inaccuracies contained in it." We regret that the whole letter is longer than we can make room for, but we give the most important points of it. "In the first place," Mrs. Lewis writes, "reference is made to the completion of my husband's 'field notes under the joint editorship of the Rev. Dr. Crosskey and Prof. Kendall'—now of Leeds. The truth of the matter is, that Prof. Kendall's only contribution to the volume is a short introduction containing a *résumé* of his own observations during the last three years—many of which seemed to throw light on the vexed questions of British glacial geology which my husband had attempted to solve. To the best of my knowledge, Prof. Kendall never saw my husband's manuscripts, and the onerous task of arranging the large collection of unfinished papers and diagrams was a labor of love on the part of the Rev. Dr. Crosskey, of Birmingham, who undertook it in compliance with my husband's parting request. The volume in question consists of a full introduction—written partly by Dr. Crosskey and partly by myself—which is followed by notes and observations made by my husband in this country [England, where Mrs. Lewis is at present residing], and then by two appendixes. The first appendix is by Prof. Kendall, as I have said; and the second, which was compiled by myself at Dr. Crosskey's request, consists of such abstracts from my husband's continental work as promised to throw light upon the problem of glacial action in Great Britain. In connection with my husband's explorations in Pennsylvania, I may state, in passing, that it was only over the *last third* of the work that my husband had the pleasure and benefit of Prof. Wright's companionship; all the foregoing portion of the terminal moraine was traced by himself alone. Further on in your article I find the remark that, 'upon completing this work [the tracing of the moraine in Pennsylvania], the two professors, *by previous arrangement*, divided the work of exploration—Prof. Wright carefully surveying the line westward, etc., while Prof. Lewis went to England to do the work of which we have spoken there.' Now as I had the privilege of sharing all Prof. Lewis's thoughts and plans since before he had the honor of making Prof. Wright's acquaintance, I can confidently state that when the work in Pennsylvania was brought to a close in 1881, my husband had no idea whatever of going to England, and that it was not till the summer of 1884 that he gave the matter serious thought."

With regard to Prof. Wright's participation in the Pennsylvania survey, Prof. Warren Upham is quoted in the sketch of Prof. Henry Carvill Lewis, published in The Popular Science Monthly for July, 1889, as saying—a statement to which no exception has ever been taken: "Prof. Lewis first became specially interested in the glacial drift and its terminal moraine during the latter part of the year 1880, when, in company with Prof. G. F. Wright, he studied the remarkable osars of Andover, Mass.; the gravel of Trenton, N. J., containing palæolithic implements; the drift deposits of the vicinity of New Haven, Conn., under the guidance of Prof. Dana; and, finally, the terminal moraine in eastern Pennsylvania between the Delaware and Lehigh Rivers. The following year Profs. Lewis and Wright traversed together the southern border of the drift through Pennsylvania from Belvidere on the Delaware, west-northwesterly more than two hundred miles, across the ridges of the Alleghanies to Little Valley, near Salamanca, N. Y., and then southwesterly one hundred and thirty miles to the line dividing Pennsylvania and Ohio, which it crosses about fifteen miles north of the Ohio River." This fully substantiates Prof. Wright's claim that he accompanied Prof. Lewis in Pennsylvania everywhere except through small portions of Northampton and Luzerne Counties and through the region extending from Pine Creek in Lycoming County to Olean in New York—or was with him through more than three fourths of the distance.

It is probably too much to say that Prof. Lewis definitely laid his plans, while engaged with Prof. Wright in the Pennsylvania survey, to make a glacial survey in England like what they were then doing in the United States; but we understand that the matter was frequently talked over by them, and was more than once introduced by Prof. Lewis. His subsequent work was exactly in the line of what he had often said remained to be done in Great Britain and ought to be done.

Mrs. Lewis makes some criticisms of the map published with Prof. Kendall's article, and protests that it "must not, in any sense,

be taken to represent my husband's personal observations as to the extent and limits of the several glaciated areas, as it bears little or no resemblance to the records which he has left of them"; and she proceeds to point out some of the points of difference, particularly in Ireland.

The map does not profess to be that of Prof. Lewis, but represents the work as completed in England by Prof. Kendall. Very likely it is imperfect in Ireland, but it gives the general facts as well as could be done before Prof. Lewis's notes are published.

We are pleased to learn from Mrs. Lewis's letter that the manuscript of her husband's book has gone to press.—EDITOR.

HABITS OF POGONIA OPHIOGLOSSOIDES.

Editor Popular Science Monthly:

SIR: In reading the very interesting article in your November number, Color in Flowering Plants, I am at a loss to understand the author's description of the orchid *Pogonia ophioglossoides*.

She says, "There is no other pogonia . . . which has its leaves *whorled* on the stem," and speaks of its "greatly elongated sepals and three-parted corolla—all *green*," etc. She also describes it as growing in the same places as the "much more abundant Indian cucumber," and as resembling it much more closely than allied orchids. It grows quite abundantly in Nantucket, but I have never found it there with whorled leaves, green flower, or growing with the medeola.

On the contrary, its single leaf, growing midway on the slender stem, first attracted my attention as distinguishing it from the *Calopogon*, of which, at first glance, I took it to be a faded specimen. I have frequently found them growing together, and have mistaken one for the other.

Gray's Manual describes exactly the species I have found as *Pogonia ophioglossoides*, so I can not think it a "form" peculiar to Nantucket. I am, therefore, considerably puzzled to account for the discrepancies, and should be glad to be enlightened.

MABEL P. ROBINSON.

EL MORA, N. J., *October* 28, 1892.

EDITOR'S TABLE.

THE EVERLASTING GHOST.

THE believers in ghosts are just now jubilant over some anticipated revelations to be made through the medium of photography. In a recent number of the Fortnightly Review the Rev. H. A. Haweis has a long article under the title of Ghosts and their Photos. He introduces the subject by a historical survey, intended to show the inextinguishable character of the ghost. Ancient history certainly does furnish a vast amount of grist for the spiritualist mill, and the Rev. Mr. Haweis lays hold of it all. The angels that appeared to Jacob were real ghosts; the prophets were mediums; Elijah was in very truth "levitated"; so also was Philip the evangelist; so also was Francis of Assisi; the "tongues" at Corinth and the tongues among the Irvingites bespoke real possession, not mere disorder of the brain; the saints did actually come out of their graves at Jerusalem and still more or less keep up the practice. All these things, and a thousand more, added to "the raps, the lights, and the materializations" of the modern *séance*, compose, in the opinion of the reverend gentleman, such a mass of evidence in favor of ghost activity in connection with human affairs that to doubt any longer becomes a little ridiculous. We fear the stigma is one which must continue to attach to ourselves for a little while longer, at any rate. Our obstinate incredulity is not shaken even by the statement, given on the authority of the Psychological Society, that out of seven thousand sane persons one woman in twelve and one man in ten had had "experiences of an occult character." We are simply moved to congratulate the gentler sex on their appreciably more restricted conversance with the works of darkness—for we suppose the term can not be altogether inapplicable to "experiences of an occult character." It may curdle the blood of some to read that "you can visit no part of

England, Scotland, or Ireland without finding, on inquiry, that within a radius of ten miles there is some house or place said to be haunted; some house that either can not get, or can not keep, tenants on account of ghosts," but to us —we can not help it—the statement simply seems a lamentably silly one for a man of so much general intelligence as the Rev. Mr. Haweis to have made.

However, the great evidence is yet to come: the ghosts are going to sit for their photographs. Whether the photographer will have to be a medium or not does not distinctly appear, but the ghosts will, in a short time, distinctly appear. Mr. Stead is working up this part of the case with unbounded zeal and faith, and the Rev. Mr. Haweis is quite confident the ghosts are going to come out all right. "Many photographers," we read, "are in the habit of casting aside plates after partial development, because they have what they call a fault—that is, a blur or marks obscuring or occupying portions of the plate. Photographers will, in future, perhaps be more wary. I heard the other day of a young lady who was photographed at Brighton, I believe, and twice the plate came out blurred. The second time she persuaded the photographer, who was about to lay it aside as useless, to develop it. The blurs, on being examined with a magnifier, proved to be faces—all the same face. She at once recognized it as the face of a rejected lover who had died." Why this young man took up the plate with so many different specimens of his face, and how he managed to prevent the rest of his spectral body from being taken, and why he stood so far away from the beloved one as to come out so small that he had to be explored with a magnifier, are questions on which, we fear, it would be vain to expect any light. Was he all "face" in his lifetime? Did the minuteness of his spirit image signify the smallness of the place he had held in the young lady's affection; or did the stand he took far in the background signify the distance at which the young lady had kept him? It is said the young lady recognized the likeness; but was this young lady wholly veracious, or was she indulging a fond fancy that the swain was still hovering round her with his face? We read sometimes of faces in the fire; and Hamlet, if we remember rightly, succeeded in getting the wise Polonius to see in a cloud the image, first, of a camel, then of a weasel, and, lastly, of a whale. As the old man gazed, conviction grew, so that in the end he was able to say with emphasis, "*Very* like a whale." Who knows but that, as the young lady gazed, conviction may have grown in like manner, and the blur have passed through various phases before it finally came out a rejected lover? One asks where this wonderful thing happened, and all Mr. Haweis can tell us is that he "believes" it was at Brighton. Perhaps so; but until the place can be given with a little more certainty, and until a good deal of corroborative evidence is forthcoming, we prefer to assign the chief share in the whole business to the young lady's imagination and the remainder to somebody else's credulity.

We are asked to believe in ghosts because in every age there have been ghost stories. But would it not be more natural to suppose that in every age the human mind has been subject to aberrations, and that some specific weakness or irregularity of the mental constitution, or of the physical organ, the brain, on which all thinking, so far as we are aware, depends, has probably given rise to this particular class of hallucinations? We can not pretend as yet to know the mind thoroughly in health and disease; but this we do know, that there are thousands and millions of persons whose lives are never intruded on by ghosts, and who know absolutely nothing of "occult" phenomena. According to the reverend gentleman's own figures, only one woman in twelve and one man

in ten has had any "occult" experiences. Now, what we should like very much to have would be a further analysis of these figures, showing the percentage of flighty or otherwise ill-balanced minds among the "occult" and the "non-occult" (if we may so apply the words) classes respectively. Our own experience would lead us to believe that the proportion would be vastly larger in the former class than in the latter. Who has not known many examples of the tremulous, nervous, hypersensitive, wonder-loving, hysterical, or semi-hysterical type of constitution among the devotees of ghost lore? And if such examples occur, as we believe they must, to the mind of every one, is it not at least a probable inference that "occultism" in its various phases has something to do with that kind of mind? The ghost may be very ancient, but we do not believe in him the more. The trouble about him is that he has made no progress since the earliest times; in fact, on the whole, he has fallen back. We should not be disposed to talk of the "levitation" of Elijah ourselves had not the reverend Mr. Haweis used the term before us; but if, following the reverend gentleman's lead, we consider the prophet's alleged translation in that light, surely it was a most successful feat in "levitation," and a little ahead of anything the modern world can show. And, speaking generally, the apparitions and visions and other spiritual or occult phenomena of ancient times had more "body" to them than those of our own day. If, therefore, the ghost has made no progress in the course of three or four thousand years, if he is just as uninstructive and inconsequent a phenomenon now as he was when we first encountered him, if not a little more so, we may perhaps be pardoned for thinking that he may be safely and fairly ignored by people who have an average amount of business to attend to. The world is still waiting for the very first message of any practical importance coming from a well-authenticated ghost, and, considering that ghosts, such as they are, have been coming and going for some thousands of years, it is high time, if they have anything to say, that they said it. We are sadly in want of light on many matters, and a well-informed ghost might conceivably be of very great assistance in human affairs. Up to the present, however, all our light and knowledge have come from patient study of the laws of Nature; and, such being the case, we prefer to stand in the paths that Science has worn and work at the tasks she assigns. Even if the ghosts succeed in getting themselves photographed, we shall not trouble ourselves much about them, till we see what the practical bearing of the whole business is. If we might venture a prediction, it would be that ghost photographs will turn out to be an utter fraud, and that, when the matter has been thoroughly explored, one more lesson will have been given to the world as to the delusive character of "occultism" in all its shapes and forms.

A SHATTERED ARGUMENT.

MANY of our readers will remember the very truculent attack made by the Duke of Argyll upon Prof. Huxley in connection with the latter's demonstration of the impossibility of the Noachian Deluge. Among the proofs of that catastrophe adduced by his Grace was the existence high up on the Welsh hills of large beds of comparatively recent marine shells. The sea had been there on the mountain tops, exclaimed the Duke in triumph, and that quite recently. One of two things, therefore, had happened: either the sea had been raised over a thousand feet above its present level, or the land had been suddenly depressed to that extent, either of which occurrences would produce a first-class flood. But what do the most recent investigators, the late Prof. Carvill Lewis and Prof. G. F. Wright, tell us on this point? The answer is furnished in our issue for De-

cember, a paragraph of which we may here quote:

"This evidence" (viz., for a recent submergence, as supposed by the Duke of Argyll and others) "consisted of shell-beds inclosed in true glacial deposits eleven hundred feet above the sea at Macclesfield near Manchester, and fourteen hundred feet above the sea at Moel Tryfaen, on the northern flanks of Snowdon in Wales. Prof. Lewis and those who have followed out the clews which he started, have proved that these shell-beds were not direct deposits during a submergence of the country, but rather beds washed out of true glacial deposits which had been shoved along by the ice in its passage over the bottom of the Irish Sea. The shells were pushed up with the mud from the sea bottom, as pebbles are known to have been in so many instances. The melting of the ice furnished the water necessary for partially working over the original deposit and sorting out and stratifying the inclosed gravel and shells."

A proof that this is the true explanation is that "the shells are not such as would haunt the same place under water. In these beds rock-haunting and mud-loving species and shallow-water and deep-water species are indiscriminately mingled together."

We see here once more the value of close and thorough observation. No point in scientific theory should be considered settled till all the facts are in. If the Duke of Argyll wants to prove that the whole of England got a dip in the days of the patriarch Noah, say about five thousand years ago, he will have to look about for other arguments. As the case now stands, the shells to which he pointed so triumphantly tell an altogether different story.

STOVES WITHOUT FLUES.

THERE has recently appeared a fresh illustration of "what knowledge is of most worth" in the dangers that come from the pitiful ignorance of the simplest facts of science still prevailing among presumably well-informed persons. Certain "patent fuels" have been put on sale, to be used in stoves without chimney connection, and are advertised as being entirely harmless. The natural result has followed. Gullible merchants, ministers, and even doctors have been buying them and nearly smothering themselves or their friends with the gases which must result from the combustion of any form of carbon. The makers of these fuels state that ventilation is required with their apparatus, but their customers reason, Why let in the cold air if the fuel is harmless, as stated? or they imagine that one opening from a room into a hallway secures "ventilation." Probably most of the victims of the patent fuels have read about the process of combustion, but they have not learned its nature from experiments that would make this knowledge real to them. Their education has been of the antiquated but not yet abandoned kind which substitutes the study of books for the study of things. As an explorer who tries to cross a deep river is drowned if he can not swim, so any one who lives in the present age, when natural forces are being put to service as never before, is badly off if he does not understand how to use these forces without letting them overwhelm him. Science is doing many wonderful things in these times, but its achievements always consist in employing the laws of Nature, never in circumventing them.

LITERARY NOTICES.

THE LOST ATLANTIS, AND OTHER ETHNOGRAPHIC STUDIES. By Sir DANIEL WILSON. New York: Macmillan & Co. Pp. 409. Price, $4.

THIS is a posthumous work, completed in accordance with the author's desire by his daughter. It is described in his note-book as "a few carefully studied monographs, linked together by a slender thread of ethnographic relationship." The thread, as nearly

as it seems susceptible of description, assumes the form of an inquiry into the probability of there having been any relationship between the developments of primitive Old World and of aboriginal New World civilization. The first essay, which gives its title to the book, embraces a critical inquiry into the origin of Plato's story of Atlantis—which is left in the great philosopher's imagination—a discussion of the legends that have been current on the subject, a presentation of scientific evidence as being decisive against such a land having ever existed; and the conclusion—while the admission is made and even the belief is avowed that the Phœnicians may have visited America, and evidences of their presence here may yet be found—that ancient American civilization was native. In the next essay, the discovery of America by the Northmen and their attempts at colonization are accepted and discussed as established facts. The essay on Trade and Commerce in the Stone Age concerns the whole world, while the evidences of trade relations between different parts of America are considered in it in full. The conclusion is expressed that the exceptional aptitude of skilled workmen was recognized and brought into use for the general benefit, and co-operation and the division of labor were known at a very early stage in the development of primitive mechanical art; that materials for manufacture were transported from remote localities, and the exchange of products was facilitated by professional traders. The native origin of American civilization is again taken up in the essay on Pre-Aryan American Man. The succeeding essay is concerning the Æsthetic Faculty in Aboriginal Races; and in the following one the Huron Iroquois are presented as a typical American race. In the paper on Hybridity and Heredity the idea, fostered by Morton, of an approximation of the Anglo-American to the red Indian type is rejected; and an interesting speculation is suggested of the future of the colored race in this country, which, left free, as it now is, to enjoy the healthful social relations of a civilized community, and protected by prejudice from any large intermixture with the white race, will survive distinct. In the last paper, on Relative Racial Brain-weight and Size, the conclusion is reached that in the remarkably exceptional characteristics established by the study of certain Peruvian crania, "we have as marked an indication of a distinctive race-character as anything hitherto noticed in anthropology."

CREATION OF THE BIBLE. By Rev. MYRON ADAMS. Boston: Houghton, Mifflin & Co. Price, $1.50.

THE author of this book is a Congregational clergyman, and he has given an excellent summary of the results of the "higher criticism." He follows Kuenen and Wellhausen, chiefly, in his views of Israelite history, beginning with the prophecies of the eighth century B. C. as a basis, and working back to the origin of the nation and forward to the introduction of Christianity. He thinks that Genesis is largely mythical, and was not composed till the Babylonish exile. He rejects the Mosaic authorship of the Pentateuch, and ascribes its composition to several authors between the sixth and eighth centuries B. C. The creation of the Bible, in fact, began with Ezra, the scribe, after the Babylonish exile. Prior to that time the sacred books of the Jews were lightly esteemed, and were tossed from pillar to post, but Ezra and his associates gathered them into a canon. The prophecies are the earliest and most reliable books of the Bible. The older parts of Genesis are products of oral tradition. The Levitical law and priesthood were not established in Israel until after the exile. Amos was the first prophet, Hosea came next, Joel and Malachi about two and a half centuries later. Isaiah wrote the first part of the book bearing his name, but the latter part was written by an unknown prophet of the exile. One of the most interesting chapters of the book is that entitled "From Gods to Gods," in which Mr. Adams shows that Israelite monotheism was developed from fetichism and idolatry. The prophets were the originators of monotheism in Israel, not Abraham, as is popularly supposed. The prophets also attacked the bloody sacrifices of the people. Human sacrifice was often practiced, even as late as Micah's time, for he protested against it. Jephthah offered his daughter in sacrifice to Jehovah; Samuel hewed Agag into pieces "before Jehovah"; and Abraham was tempted to sacrifice Isaac.

The books of Job and Daniel are "fictitious." They are not false, but they are

true only in the sense that novels, poems, allegories, and parables are true. Job is a magnificent poem and a profound piece of philosophy, written by some unknown sage at an unknown date. Daniel is one of the several apocalypses which appeared about B. C. 150, called forth by the sufferings of the Jews under their Greek oppressors. The author thinks that David did not write many if any of the Psalms, and they were attributed to him simply because he was Israel's greatest king, a lover of music, and the patron of poets and prophets. "The real power of the Old Testament is in its poetry," but we must "resolutely reject" many of the sentiments of the Psalms, such as their imprecation of divine wrath upon the enemies of Israel. Mr. Adams gives a fine sketch of the Persian, Greek, and Roman influence upon the Jewish nation and religion. It is commonly believed that Judaism degenerated between the exile and the birth of Jesus, but our author rightly says, during that period "the principal preparation was made for the introduction of Christianity." The Holy Scriptures were translated into Greek; synagogues were built in Alexandria and wherever the Jews were dispersed and settled. Their ideas of the world were broadened and their religious views were liberalized. Devout and learned scribes traveled from place, to place teaching the people. The Pharisees, Sadducees, and Essenes propagated various phases of religious belief and practice. The book of Ecclesiastes, written about 200 B. C., and therefore not by Solomon, shows us the effect Greek philosophy had on Jewish thought. It produced pessimism. "When the fullness of the times was come," God sent forth the great teacher of Nazareth to fulfill the law and the prophets. Mr. Adams accepts the critical and rational view of the Gospels, concluding that they were compilations by unknown authors from oral tradition and perhaps written sources, between A. D. 70 and 150.

All "miracles" are rejected, except those that may be explained as extraordinary natural events. The bodily resurrection of Jesus and his birth of a virgin, in particular, are denied, and Mr. Adams thinks that a better statement of the Incarnation is a necessity. Commenting upon the doctrine of the Logos in the Johannine Gospel, he says: "The Word which has always been with God and is God becomes the rocks of the world, the water of the oceans, the stars of the sky, and in due process becomes flesh and dwells among us, full of grace and truth. Nothing is made without the Word. Jesus," he adds, "certainly did not build the worlds, but that manifesting Spirit, which became flesh in him, has always been uttering God."

On the whole, this book accomplishes its purpose very satisfactorily. The writer covers a large field, and it is remarkable that he has made no more mistakes than he has. His thought is clear and suggestive; his style easy and flowing; his spirit earnest and reverent; his conclusions judicious and undogmatic. Those who are not familiar with the subject treated will find the book very instructive; and those who are well versed in such matters will find it a good summary of scholarly opinions on the most important religious problem of the day. If Mr. Adams had appended a list of such authorities as those mentioned in the preface, he would have added to the value of his book, for one of the chief functions of such books is to make their readers read further and more thoroughly.

THE CHEMICAL BASIS OF THE ANIMAL BODY. An Appendix to Foster's Text-book of Physiology (sixth edition). By A. SHERIDAN LEA, D. Sc., F. R. S., University Lecturer in Physiology in the University of Cambridge, etc. New York and London: Macmillan & Co., 1893. Pp. 288. Price, $1.75.

HERETOFORE the chemical basis of the animal body has been presented in a brief appendix incorporated with the final book of Prof. Foster's Text-book of Physiology. But the advances of science, as well as the demands for more thorough knowledge, have expanded the fifty pages that sufficed, in the former editions of that text-book, to describe this subject, into the present volume. Dr. A. Sheridan Lea was the author of that appendix, as he is of this volume that constitutes a treatise on the chemical substances occurring in the animal organism.

In the first portion of the volume we find the section on proteids enlarged by the addition of the discoveries that have been made regarding those substances; methods of preparation are clearly and succinctly de-

scribed, and the various reactions are explained. The section describing peptones now includes albumoses, that are classed with the former, both on account of their close relationship and for convenience. The author calls attention to the fact that various substances that have been described as peptones have consisted, to an extent at least, of a mixture of true peptones with variable quantities of albumoses, and that our knowledge of true peptones is at present in a state of transition. In fact, as he truly states, until some new property of proteids is discovered by which their absolute purity may be determined, the question of the constitution of proteids will probably remain unsolved.

A new section is added on the enzymes, in which we find descriptions of trypsinogen, pialyn, rennin, muscle-enzyme, and urea-enzyme.

In the section on the nitrogenous non-crystalline bodies allied to proteids, descriptions of the mucin of bile, of that of the submaxillary gland, and of that of the umbilical cord, of gelatin-peptones, of neurokeratin, of chitin, and of nucleo-albumins have been added. In the section on carbohydrates the dextrins are now well described; while the sugars are satisfactorily explained by Emil Fischer's able researches regarding the several members of this class of carbohydrates.

In the sections on the fatty acids and fats, on the amides and amido-acids, on urea and the uric-acid group, on the bile acids, and on the coloring matters and pigments of the animal body, much recent material has been incorporated, while a brief section is devoted to ptomaines and leucomaines.

The volume is a most useful addition to the literature of the subject; the numerous references it contains will permit the student to consult original authorities should he so desire; while in general an immense amount of time will be saved for those studying this subject by this collocation of results that are scattered throughout medical literature.

ENGLISH CLASSICS FOR SCHOOLS. New York: American Book Company, 1893.

AN admirable idea is embodied in the series of English Classics for Schools of the American Book Company—a series in which the masterpieces of English literature are presented in attractive form for reading in class or for supplementary reading. Of this series there are now sent to us Ten Selections from the Sketch Book of Washington Irving, Shakespeare's Tragedy of Julius Cæsar, and his Comedy of Twelfth Night, at the price of twenty cents each, and Sir Walter Scott's Ivanhoe at fifty cents. With the text are given brief notices of the author, with analyses of the particular works.

FINGER PRINTS. By FRANCIS GALTON. New York: Macmillan & Co. Pp. 216. Price, $2.

MR. GALTON'S attention having been directed to the individuality and significance of the marks made by the tips of the fingers, he was surprised when he came to inquire into the subject at perceiving what had been done, and what a promising field of inquiry still lay in it. He found it of real importance and investigated it, with results, truly curious and valuable, which are given in this book. The account begins with notices of the previous employment of finger prints among various nations, with objects partly superstitious and partly ceremonial; then various methods of making good prints are described at length; next, the character and purpose of the ridges, whose lineations appear in the finger prints, are discussed. These preliminary topics having been disposed of, the inquiry proper begins with a discussion of the various patterns formed by the lineations, illustrated by plates of the principal varieties. The question is raised as to the persistence of the patterns, or whether or no they are so durable as to afford a sure basis for identification, and is answered, except as to proportions, in the affirmative. An attempt is made to appraise the evidential value of finger prints by the common laws of probability. A succeeding chapter deals with the frequency with which the several kinds of patterns appear on the different digits of the same person; and in it unexpected relationships and distinctions are established between different fingers and the two hands. Methods of indexing are discussed and proposed, by which a set of finger prints may be so described that it may easily be searched for and found in any large collection. The practical results of the inquiry are discussed as to its possible

use in differentiating a man from his fellows; and the finger prints are found to afford one of the most certain marks of identification. The question whether patterns are transmissible by descent is answered affirmatively; and this leads to the estimation of their use in indicating race and temperament. In the last chapter the right is discussed of the nine fundamentally differing patterns to be considered as different genera, and of their more characteristic varieties to rank as different genera or species, as the case may be, with affirmative conclusions.

SOUND AND MUSIC. By the Rev. J. A. ZAHM. Chicago: A. C. McClurg & Co. Pp. 452. Price, $3.50.

THE author of this work is Professor of Physics in the University of Notre Dame. The main purpose of the book is to give musicians and general readers an exact knowledge, based on experiment, of the principles of acoustics, and to present at the same time a brief exposition of the physical basis of musical harmony. The author believes that, in view of the attention now given to theoretical as well as practical music in European and American conservatories, this presentment can not be considered altogether untimely. The treatise is based on the recent and most exact observations of modern physicists, most prominent among whom are Helmholtz and Koenig, as well as the works of the older acousticians, and is intended to include a summary of all that has been learned and determined down to the date of publication. To Koenig, the latest of these investigators, and the one probably who has carried our knowledge of the philosophy of music to the most successful results yet obtained, personal obligations are acknowledged. The volume has grown out of a course of lectures that were given in 1891 in the Catholic University of America, Washington, D. C. These, however, have been thoroughly revised, with the purpose of making the exposition of the subject more complete than was possible in lectures actually delivered, so that it is practically a new work. Yet the lecture form has been retained as being more animated and picturesque, and more in keeping with the character of a work that deals so largely with apparatus and experiments. Of the illustrations and experiments many were prepared expressly for this work, while others are to be found only in the more recent French and German treatises on sound and music. The first chapter, beginning with a reference to the relation of the science to the art of music, is devoted to the explanation of the Production and Transmission of Sound and the Nature of Sonorous Vibrations. In the next two chapters the laws of Loudness or Intensity of Sound and Pitch are considered, with a description of Koenig's *Grand Tonomètre Universel*, and the subjects of Velocity, Reflection, and Refraction of Sound. The topics of Musical Strings, Vibrations of Rods, Plates, and Bells, and Sonorous Tubes follow; after which come the theoretical subjects of Resonance and Interference, Beats and Beat-tones, the Quality of Sound, and Musical Intervals and Temperament.

TEXT-BOOK OF THE EMBRYOLOGY OF MAN AND MAMMALS. By Dr. OSCAR HERTWIG, Professor Extraordinarius of Anatomy and Comparative Anatomy, Director of the II Anatomical Institute of the University of Berlin. Translated from the third German edition by EDWARD L. MARK, Ph. D., Hersey Professor of Anatomy in Harvard University. With 339 Figures in the Text and Two Lithographic Plates. London: Swan, Sonneschein & Co. New York: Macmillan & Co., 1892. Price, $5.25.

THE fact that this work possessed sufficient merit to go through three editions in German in the four years following its first publication, implies an intrinsic merit; for there is no paucity in the literature of this subject, while the new discoveries that are constantly being reported by investigators tend to make a comparatively recent book behind the times, speaking from a scientific standpoint.

In the first chapter the sexual products are described, and following this is an explanation of the phenomena of the maturation of the egg and of the process of fertilization, the author presenting the theory that the female nuclear substance transmits the peculiarities of the mother, the male nuclear substance those of the father. This is an expansion of the theory of fertilization into one of transmission.

We do not think that the translator has been felicitous in his choice in using the term "process of cleavage" for the more

usual term of segmentation of the ovum, even though he has the precedence afforded by Prof. Huxley's employment of a term that should have been left to its original scientific use in geology and mineralogy.

The methods of development of the two primary and of the two middle germ layers—the so-called gastræa theory and cœlom theory—are presented in separate chapters. The author maintains that at the close of segmentation there is only one germ layer present—the epithelium of the blastula. From it the remaining germ layers arise by the processes of invagination and evagination—the inner germ layer being formed by means of gastrulation, the two middle germ layers being formed by the formation of the body cavities, in that two body sacs are evaginated from the cœlenteron and grow out between and separate the two primary germ layers. After their origin the middle germ layers are differentiated into several fundaments (rudiments) by processes of folding and constricting off.

The development of the connective substance and blood is explained by means of the mesenchyme germs. This is followed by chapters on the establishment of the external form of the body and on the fœtal membranes of reptiles, birds, mammals, and man.

The consideration of the science of the embryology of organs is divided into four sections, comprising the morphological products of the inner, of the middle, of the outer, and of the intermediate germ layers. This is, of course, an arbitrary division, for the teeth arise from the intermediate and the outer germ layers, while the alimentary canal and its glands contain elements from the inner, middle, and intermediate layers.

Space forbids any extended consideration of the features pertaining to these latter topics. The work is certainly a comprehensive presentation of the subject, and the translator has performed his arduous task in a satisfactory manner.

COMMERCIAL ORGANIC ANALYSIS. By ALFRED H. ALLEN. Volume III, Part II. Philadelphia: P. Blakiston, Son & Co. Pp. 584. Price, $5.

EACH successive portion of this valuable work testifies to the masterly ability with which its author has handled a large and difficult undertaking. The present part deals with Amines and Ammonium Bases, Hydrazines, Bases from Tar, and Vegetable Alkaloids. The substances of chief commercial importance that are treated are, therefore, drugs, such as aconitine, atropine, cocaine, morphine, quinine, and their allies; the alkaloids of coffee, tea, and cocoa, and the aniline colors. Substances of special interest at the present time which fall within the scope of this part are antipyrine and certain other antipyretics. A third part of Volume III is to be issued to complete the treatise, and it is gratifying to note that the success of the work in its enlarged form warrants the author in announcing a new edition of the earlier volumes.

RAILWAY INJURIES, with Special Reference to those of the Back and Nervous System, in their Medico-legal and Clinical Aspects. By HERBERT W. PAGE. New York: William Wood & Co. Pp. 157.

THE aim of this book is to give an account of the injuries received in railway and similar accidents that become the subject of medico-legal inquiry. The author has long been a student of this branch, having published in 1883 a work on Injuries of the Spine and Spinal Cord and Nervous Shock, to which he had given several years of preparation, and having continued his observations since. While injuries of all kinds and degrees are caused by railway accidents, they do not differ for the most part from those which are seen after other forms of violence. Even the injuries in the back received in railway accidents do not differ from similar injuries received in other ways; but their frequency, and the character they impress on the features of many other forms of injury, demand for them a place by themselves. It is, in fact, a peculiarity of railway accidents that these injuries of the back are nearly always produced, whatever other injuries may occur, and even though there may not be other injury; that the patient is often not aware of them till some time afterward, and that their direct and indirect effects are often widespread and long continued. Vastly more numerous and even more important than these are the cases of "general nervous shock"—an unprecise term applicable rather to the whole of the clinical circumstances of

the case than to any one symptom which may be presented by the injured person. The characteristics of the cases described by it indicate some functional or dynamic disturbance of the nervous equilibrium or tone, rather than structural damage to any organ. Another class of effects is included under the designation of fright neurosis or traumatic hysteria. The diagnoses of these phenomena are complemented by the citation of considerable numbers of cases which illustrate the almost capricious variety of the forms under which they are manifested. In treatment a pre-eminently important factor is rest; but, besides this general remedy, there are special forms of affection that require special applications. The mental condition is all-important; and in this connection special stress is laid upon the effect of the expectation of compensation, and upon malingering, into which the patient is to a greater or less extent seduced unintentionally and unconsciously by the trend of his thoughts and fancies; so that complete recovery is not assured till the mind is cleared, to which payment of damages contributes greatly; yet this is predicated without reflection on the character, motives, or entire honesty of the patient. The closing chapters are devoted to the discussion of this branch of the subject in its medico-legal aspects.

A Text-book of Physiology. By M. Foster, M. A., M. D., LL. D., F. R. S., Professor of Physiology in the University of Cambridge, etc. Sixth edition, revised. Part IV. London and New York: Macmillan & Co., 1891.

This part of this excellent text-book treats of the physiology of the various senses, of that of certain special muscular mechanisms, as of the voice, of speech, and of locomotion; of the tissues and mechanisms of reproduction, including impregnation, menstruation, pregnancy, parturition, the phases of life, and death. Preceding the physiology of each organ there are descriptions of its anatomy and histology, as in the other parts of this work.

The great caution that Prof. Foster displays throughout the work in judicially presenting both sides of a moot point is well shown in the section on color sensations. Both the Young-Helmholtz and the Hering theory of color perception are explained, but the author is inclined to accept the latter, both because there is a recorded case in which only white and black could be seen, and because the phenomena of peripheral color vision better accord with Hering's theory.

In the chapter on hearing the author states that the exact nature of the process by which the vibrations of the perilymph, produced by waves of sound, give rise to auditory impulses is uncertain. Even accepting the theory that the basilar membrane may be considered as consisting of a number of parallel radial strings, each capable of independent vibrations, the other structures in the auditory epithelium present problems that are as yet unsolved; for the true function of the rods of Corti and of the reticulate membrane of which these form a part, of the cells of Deiters, and of the inner as distinguished from the outer hair-cells, are yet unknown.

The author considers, in the section on taste and smell, that certain recorded cases lead to the provisional conclusion that the gustatory fibers are fibers belonging to the fifth nerve, though they may reach the tongue partly by way of the glosso-pharyngeal, partly by way of the chorda tympani nerves.

While we agree with the author that cutaneous pain is a separate sensation, developed in a different way in the skin than is pressure or temperature sensation, we think that he should have laid stress on the latter as being developed in a different way than is pain or pressure sensation. In fact, recorded cases of nervous diseases suggest that, though correlated, the pressure, pain, and temperature senses are distinct entities.

He does not regard "muscular sense" as an appropriate term for the recognition of impulses that are derived not only from the muscular fibers, but also, and possibly to a large extent, from the tendons and other passive instruments of the muscles. Therefore this so-called muscular sense is the outcome of afferent impulses proceeding from the periphery and started in the parts concerned in the movement, and it should not be described by a term that implies a single source of the phenomenon.

The entire volume exhibits the same care-

ful presentation of the subjects under consideration that has characterized Prof. Foster's former work, and has made this in the past one of the best works on physiology that we have; and the incorporation of the more recent discoveries in that science in this volume sustains its high standard. The only thing that detracts from this volume is the omission of an index.

THE GREAT WORLD'S FARM. By SELINA GAYE. New York: Macmillan & Co. Pp. 365.

THIS book is described in the subtitle as "Some Account of Nature's Crops, and how they are grown." It maintains the proposition that "the whole earth is one great farm or garden, almost everywhere covered with vegetation, and bringing forth crops of the most luxuriant and varied kind"; and that Nature farms in ways of her own, on a large scale and without fuss, with a tillage of the most thorough kind, though it may be carried on without steel plows, and so quietly as to escape our notice. "There are vast pasture-lands here, there are extensive forests there; there are woods, jungles, heaths, moors, downs, but they have all been planted; and the soil was prepared in the first instance, and has been renewed since, by laborers who are not less truly deserving of the name of laborer than the plowman, though they do not work with his implements." Of these laborers we are introduced first to the "pioneer laborers"—the gases of air and water—"which wear away the very hardest rocks by degrees"; then to the "soil-makers"—the lichens which sprout in the *débris* of the weathered rocks, and the roots of which, with those of the plants that follow them, continue the work done by air and water; to the "soil-carriers"—the rivers; the "soil-binders"—grass and plant roots; and the "field laborers"—worms and burrowing insects and animals, which loosen the soil; the work of which in the field particularly under view is graphically described. The work of water and roots, and the reason for deserts, are more fully considered. The office of plants in drawing food from the soil and leaving it there when they die in a more assimilable condition, and leaves and their work, are described—the influence of climate, "blossom and seed," the meaning of fertilization and the work of insects in assisting the process, and the methods of diffusion, are explained; and chapters follow on the Chances of Life, Friends and Foes to Plant Life, Nature's Militia, and Man's Work on the Farm. The whole is a successful attempt to present knowledge of the phenomena and processes of growth in an attractive form, to which a few excellent illustrations lend additional grace.

MANUAL OF QUALITATIVE BLOWPIPE ANALYSIS AND DETERMINATIVE MINERALOGY. By F. M. ENDLICH. New York: The Scientific Publishing Co. Pp. 456. Price, $4.

IN this treatise the use of the blowpipe in analytical and determinative work is treated with great fullness. The chapter on appliances and flames is fully illustrated. This is followed by descriptions of the several modes of examining minerals, including some operations with wet reagents. A dozen pages of tables giving reactions for the oxides of earths and metals constitute Chapter III. Some seventy pages are devoted to prominent blowpipe reactions for the elements and their principal mineral compounds, arranged alphabetically under the names of the elements. Special suggestions as to the treatment of alloys, metallurgical products, and pigments are given; and these are followed by a systematic method of qualitative analysis before the blowpipe. Over a hundred pages of determinative tables are given, in which more than four hundred species of minerals are described. In these tables seven chief divisions are made—namely, metallic malleable minerals, flexible minerals, sectile malleable minerals, minerals with and those without metallic luster, earthy minerals, and hydrocarbon compounds. The methods of Prof. Richter, of Freiberg, have been largely followed in this manual, the author having been one of Richter's pupils.

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POPULAR MISCELLANY.

Extent of the Great World's Fairs.—In his paper before the British Society of Arts, on the coming Chicago Exhibition, Mr. James Dredge, of the Royal British Commission, presented a summary of previous World's Fairs and their results. The first great World's Fair was held in Hyde Park, London, in 1851, in a single building, 1,851 feet long and 450 feet wide. It accommodated not quite 14,000 exhibitors, half of whom came from the colonies, and closed with a net profit of $750,000. The first World's Fair in the United States was held in New York in 1853, accommodated 4,100 exhibitors within an area of 263,000 square feet, and lost $300,000. The first Paris Exhibition, in 1855, covered 1,886,000 square feet, had nearly 24,000 exhibitors, 144 of whom were from the United States, and was visited by 5,162,000 persons.

Smaller exhibitions were held in Melbourne in 1854, Turin in 1856, Brussels in 1857, Lausanne in 1858, and Hanover in 1859. The second International Exhibition in London was held in 1862, covered 17 acres, was visited by 6,210,000 persons, and lost $2,001,500. The second Great Exhibition in Paris, in 1868, covered 11 acres besides many annexes, and had 52,200 exhibitors and 10,200,000 visitors. The Great Exhibition at Vienna in 1873 failed on account of the cholera. The Centennial Exhibition in Philadelphia in 1876 occupied 285 acres; was participated in by 32 foreign nations, while the United States furnished 30,864 exhibitors, Great Britain and its colonies 3,584, and Spain 3,822; and was visited by 9,911,000 persons. The Paris Exhibition of 1878 covered 54 acres, with annexes and special buildings; had 52,835 exhibitors, of whom 1,203 were American; was attended by more than 16,000,000 visitors; and lost $8,580,000. The Paris Exhibition of 1889 exceeded all these, and had 30,000,000 visitors. The Chicago Exhibition will occupy 666 acres, of which more than 200 acres will be crowded with buildings. The total expense of it will be between $8,000,000 and $10,000,000.

New Studies for Grammar Schools.—The Association of Officers of Colleges in New England, at its meeting held at Williams College in November, 1892, recommended for gradual adoption in the programme of New England grammar schools the introduction of elementary natural history in the earlier years as a substantial subject, to be taught by demonstrations and practical exercises rather than from books the introduction of elementary physics into the later years, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves; the introduction of elementary algebra at an age not later than twelve years; the introduction of elementary plane geometry at an age not later than thirteen years; the offering of opportunity to study French, or German, or Latin, or any two of these languages, from and after the age of ten years; the increase of attention in all class-room exercises in every study to the correct and facile use of the English language. In order to make room in the programme for these new subjects, the association recommends that the time allotted to arithmetic, geography, and English grammar be reduced to whatever extent may be necessary.

Rocks and Waters of Arkansas.—Arkansas, says Prof. Branner, in his report on the mineral waters of that Commonwealth, is a well-watered State. Besides the springs of which analyses are given in the report, hundreds of beautiful, free-flowing springs of excellent water gush from hillsides and valleys in all parts of the State. In the limestone region north of the Boston Mountains such springs are especially abundant, large, and beautiful. They are not mineral waters, properly speaking, but they are more valuable than if they were. Some of these springs are so big that they are utilized for driving mills, cotton gins, and other machinery, and, as their discharges are subject to little or no fluctuations throughout the year, they are free from the dangers of freshets and the risks of droughts. Besides these truly gigantic springs, no one who travels through north Arkansas can fail to be impressed by the great number of large and beautiful springs to be found at every town and village, to say nothing of those at almost every farmhouse. Many springs are remarkable for the purity of their waters. The waters of the Hot Springs claim the place of first importance in any consideration of the medicinally valuable waters of the State. It is the custom to speak of a large number of the hot springs, variously estimated at from fifty to seventy; but, while hot water does issue from the ground at as many or more points, it is hardly worth while to dignify each of these trickling streams with the name spring. Much curiosity is naturally manifested on the part of visitors to hot springs regarding the cause of the high temperature of the waters. In the Yellowstone National Park, where hot waters abound, the activity of igneous agencies offers a ready answer to such questions; but in Arkansas, where nearly all the rocks to be seen are of sedimentary origin, there is no evidence of recent volcanic activity. Some of the theories advanced are interesting only as curiosities, and are not mentioned by the author as having any other value. For example, it has been suggested that the heat comes from coal burning beneath the surface

of the ground. It is perhaps enough to say that the coal measures to which coal is confined in Arkansas lie far to the north of Hot Springs, and that the hot waters come up through Silurian rocks which contain no coal. Of the theory that heat may be produced by chemical action, it may be said that the water itself gives no evidence of its having received its heat in this way, its chief foreign constituent being carbonate of lime. So far as the geology of the region is concerned, if there were no hot water in the vicinity none would have been anticipated on geologic grounds alone. Notwithstanding a writer at the beginning of the century mentioned having seen a volcanic outburst and streams of molten rock near Hot Springs, there is no evidence of such recent eruptive action, which could not have taken place without leaving readily recognizable traces. There are, however, eruptive rocks near Hot Springs, although they certainly were not thrown up during the last hundred years; and it is probable that the heat of the water is derived from its having come in contact with hot rocks, the cool edges of which may or may not be exposed at the surface.

Ancient Outlet of the Great Lakes.—Among the latest geological observations of Prof. G. F. Wright is the discovery of a former outlet of the Great Lakes through Lake Nipissing and the Mattawa River to the Ottawa. It has long been recognized that an elevation of less than fifty feet at Niagara or a depression of an equal amount at Chicago would cause the lake waters to flow into the Mississippi instead of the St. Lawrence. Recent railroad surveys have further shown that a subsidence amounting to only a trifle more than a hundred feet would turn the current from Lake Huron through Lake Nipissing and the course already mentioned. Prof. Wright has discovered evidence that this condition at one time prevailed. Lake Nipissing is scarcely seventy feet above Lake Huron, and empties into it through French River. The western extremity of Trout Lake, the source of the Mattawa, is less than three miles from North Bay on Lake Nipissing, and is separated by a wide, swampy channel which is only about twenty-five feet above the level of either lake. It is large enough to conduct the waters of the Great Lakes over into the present water-shed of the Ottawa when called upon to do so. "On looking for more positive evidence, we find it in a clearly defined shore-line of well-rounded pebbles extending upon the north side of the channel from one lake to the other, and at a uniform height of about fifty feet above the connecting channel. This shore-line is as well defined as that on the banks of the Niagara River, just west of the present cataract. Such a deposit could not have been formed along this connecting depression except by a stream of vast size passing from Lake Nipissing into the Mattawa. It is, however, on going down to the junction of this outlet with the Ottawa that the most positive and striking evidence is seen. For ten miles above the junction signs of the old river terraces are more or less visible high above the present stream; but at the junction there is an accumulation of river deposits, unparalleled, probably, by anything else in the world. The lower angle of the junction between the two streams is filled to a height of eighty feet or more above the present water level with a bowlder-bed about half a mile in width, and extending up the Mattawa for nearly a mile, where it shades off into finer material. On the upper angle the Mattawa is bordered by a terrace equally high, but consisting for the most part of fine gravel." The accumulation is clearly a terrace and not a simple glacial moraine; and that it is a delta brought down by the Mattawa and not by the Ottawa is shown by the fact that it has dammed the latter stream, producing in it deep water above and rapids below, according to the well-known law of river bars.

Traveling and Camping in Egypt.—Dr. Frederick Peterson, of this city, recommends winter camping in Egypt as a hygienic measure. He finds it something luxurious, and says: "I have camped out on shooting expeditions in Nebraska, Dakota, and other Western places, and endured hardships that I should not care to experience again. But in Egypt, where labor and carrying cost next to nothing, where everything in the way of furniture and supplies can be stored away somewhere on a camel; where every day can be foreseen to be rainless and beautiful, life in tents becomes a pleasure. It is al-

ways well to have some objective point in view to reach, and among the pleasantest desert trips with tents and camels are those to the Sinaitic Peninsula, to the Natroon Lakes, to the Fayûm, and to several other oases to the west of the Nile. Probably the warmest and driest for an invalid would be that from Assiût, Girgeh, or Esneh to the Great Oasis. But one may camp on the edge of the desert, traveling southward along the Nile, in that way having the advantage of more interesting surroundings; for some people might find the desert monotonous." On a trip to Wadi Natroon, where they spent ten days, "we were a party of three, and had eight camels with their drivers, a dragoman (interpreter), desert guide, cook, hunter guide, and a boy; two tents, three folding bedsteads with mattresses, two folding tables, chairs, rugs, cook-stove, fuel, water, rifles and shot-guns, and provisions for all the party, camels included. Camel-riding becomes easy after a time. One can assume almost any position, even lying down and going to sleep, and one can read with ease. Ladies are not at all debarred from taking such trips. Everything necessary can be procured in Cairo, and the expense should not be over five or seven dollars per day for each traveler."

The River from the Lucie Glacier.—The most novel and interesting feature in the Lucie Glacier, Alaska, as described by Mr. Israel C. Russell, is a glacial river which bursts from beneath a high archway of ice and flows for about a mile and a half through a channel excavated in the ice, then to enter the mouth of another tunnel and become lost to view. The stream is swift, and its waters are brown and heavy with sediment. Its breadth is about one hundred and fifty feet. For the greater part of its way, where open to sunlight, it flows between banks of ice and over an icy floor. Fragments of its banks and portions of the sides and roof of the tunnel from which it emerges are swept away by the swift current or stranded here and there in midstream. The archway under which the stream disappears is about fifty feet high, and the tunnel retains its dimensions as far as one can see by looking in at its mouth. Where the stream emerges is unknown; but the emergence could no doubt be discovered by examining the border of the glacier some miles southward. No explorer has yet been bold enough to enter the tunnel and drift through with the stream, though possibly this could be done without great danger. The greatest risk in such an undertaking would be from falling blocks of ice. While the author was standing near the mouth of the tunnel there came a roar from the dark cavern within, reverberating like the explosion of a heavy blast in the chambers of a mine, that he did not doubt marked the fall of an ice mass from the arched roof. At the mouth of the tunnel there are always confused noises and rhythmic vibrations to be heard in the dark recesses within. The air is filled with pulsations like deep organ notes. It takes but little imagination to transform these strange sounds into the voices and songs of the mythical inhabitants of the nether regions.

Nansen's Plan for reaching the Pole.—The main principle of Dr. Fridtjof Nansen's plan for reaching the north pole, as it was described by him recently at a meeting of the Royal Geographical Society, is that of working with the forces of Nature rather than against them. In this view the shortest and most certain route to the pole is probably to be found in the ocean current running north from Siberia and south by Greenland. The existence of such a current seems to be proved by the floating of relics of the Jeannette from where she sank in the waters north of Siberia apparently across the polar sea to the vicinity of the southwest coast of Greenland, and by the frequent appearance of Siberian objects in Greenland waters. Dr. Nansen's ship has been built with especial reference to its resisting the pressure of the ice. It is as small as possible consistently with its carrying the coal and stores that will have to be taken along. It is shaped, avoiding perpendicular lines and angles, so that in case of an ice crush it can not be nipped, but, with regularly sloping sides, shall permit the ice to glide under it and lift it up. It will be one hundred and twenty-eight feet long over all, with thirty-six feet greatest beam, a draught of twelve feet with light cargo, and a bearing capacity of three hundred and eighty tons of coal and cargo. It will be built almost solid, and will be rigged as a three-masted

fore-and-aft schooner. The expedition is expected to start in the spring. It will try to make the farthest possible point north in open water, and, when it can get no farther, will run into the ice at the most favorable spot, and from there trust entirely to the current running across the polar region. The possibility of the ship being, after all, crushed by the ice is provided against by having two boats aboard, with which the men will move with their provisions upon the ice and camp there. Thus the journey would be continued, with the only difference that there would be two small ships standing on the ice instead of the big one lying between the floes. When they emerged into the open sea on this side of the pole there would not be any great difficulty in the boats; such a thing had been done many times before. The chief difficulty would be to get duly into the current north of Siberia; when this was done, they must be carried some where northward. Whether he succeeded or not, the author was convinced that this was the way in which the unknown regions would some day be crossed. Possibly the current would not carry them exactly across the pole, but it could not easily be very far off; and the principal thing was to explore the unknown polar regions, not to reach exactly that mathematical point in which the axis of our globe has its northern termination.

Terra Cotta Roofing Tiles.—In his very interesting study of that subject, Prof. E. S. Morse mentions it as a noteworthy fact that the earliest type of terra cotta roofing tile ever exhumed still forms the roof covering of the greater mass of mankind to-day. The enduring nature of these objects, he adds, will ultimately enable one to trace the paths followed by tile-making races in their various migrations. The roofing tile has a considerable antiquity, for its appearance in Greece dates back to the earliest dawn of Greek art; and yet before this, in Asia Minor, there was a time when the tile was not, for, though in Schliemann's Ilios many other kinds of pottery were found in great abundance, there was no trace of tiles. It is probable that the roofing tile was introduced into Greece from the East fully developed. The sloping roof must have preceded the roofing tile by many thousands of years; at the outset, bark, straw, thatch, rough stones, and similar substances were used until better devices were made, which finally terminated in the terra cotta roofing tile. The shape of the earliest form of tile—a normal tile, as Prof. Morse calls it—suggests its derivation from the bark thatch. It consists of a wide under piece (*tegula*) slightly curved, and a narrow semicylindrical piece (*imbrex*), which was placed in an inverted position so as to cover the junction of two adjacent *tegulæ*. So, in roofing with bark, we would put down two pieces, concave side up, and cover the crack between them with a piece concave side down. A second type of tile is the pan tile or S-tile, which has a double flexure, forming in section a figure like that of the letter S laid upon its side (ƨ). This is an evident adaptation from the normal tile, in which the two elements, *imbrex* and *tegula*, are combined in one piece. A third type, the flat tile, or plain tile, has no genetic relation to the other forms, but is simply a shingle in terra cotta. With few exceptions, the normal tile is the only form used in Asia, Asia Minor, Greece, Italy, Sicily, Spain, the countries bordering the southern shores of the Mediterranean, and all the Spanish and Portuguese countries and colonies in both hemispheres. The pan tile, or Belgic tile, prevails in the countries around the North Sea and the Baltic; and the flat tile in France and central Europe, away from the Mediterranean.

The Disinclination to meditate.—A suggestive essay is published in the London Spectator on the Dread of Thought, in which, remarking upon the necessity of people having something with which to occupy their minds—a book, for instance—when left to themselves, the writer asks the questions: "Why is it natural for a man to dread being thrown back upon his own thoughts? Why should he find meditation so unnatural, and reading so natural?" The writer believes that the dread of thought (a little too strong a term, for it is really rather a neglect or ignoring of thought) "in a great measure comes from lack of habit. All children pass a good deal of time in thinking, but men, in the press of business and pleasure, forget how to think, and grow to regard reading as the only possible way of passing the time quietly. . . . We venture to think, however,

that a very little patience, and a very little practice, would soon make most men give up their dread of thinking, and would make an hour spent without books or talk a pleasure instead of a pain. No doubt this is not true of all men. There are certain persons cursed with a constitutional melancholy so deep that it is impossible for them to think cheerfully. . . . These, however, are the abnormal cases. The ordinary man at ordinary times has no real reason for dreading his thoughts. It is merely want of habit that makes him dislike thinking. Let him make the plunge, and select something definite to think about, and ten to one he will find following a train of thought a very agreeable exercise. Letting the mind veer backward and forward like a weathercock, at the suggestion of this or that external circumstance, is, of course, dull and worrying; but the man who knows how to think does not do that. He thinks, as he reads, with a definite purpose." The writer concludes by observing that "the man who trains his mental powers by meditation and by following out lines of thought, obtains an intellectual instrument a hundred times more powerful than he who is content never to think seriously and consecutively. The things one merely reads about never stick. Those on which one thinks become permanent acquisitions. Hence, the man who is never afraid of thinking, and who does not dread 'that cursed hour in the dark,' is at a distinct advantage on every ground. He passes the time without being bored, and he strengthens his mind. . . . The man who can enjoy and make use of his own thoughts has a heritage which can never be alienated. Even blindness for him loses some of its terrors."

The World's Mineral Industries.—The reviews of the mineral industry, published yearly in a statistical supplement of the Engineering and Mining Journal, have been rising every year to increased value and importance. The publishers of the journal have decided to issue those for the last year in a large octavo volume, under the title of the Mineral Industry, its Statistics, Technology, and Trade, both in the United States and Foreign Countries, from the Earliest Times to the Close of 1892. It will treat the substances which are the objects of mining for profit, from scientific, technological, and economical points of view, describing the modes of occurrence of the minerals, their exploitation and preparation for the market, and the statistics of the trade in them.

The Material of Folk Lore.—Mr. George Laurence Gomme maintains, in his Ethnology in Folk Lore, that the constituent elements of folk lore—consisting as they do of beliefs, customs, and traditions that are far behind civilization in their intrinsic value to man, though they exist under cover of a civilized nationality—must in general be traceable to the survival of a condition of human thought more backward, and therefore more ancient, than that in which they are discovered, and which may, therefore, conveniently be called with reference to it a condition of uncivilization. It follows that, as an element of uncivilization, existing side by side with civilization, its development must have been arrested at the point where the civilization began. It may have experienced modification, and, indeed, in most cases has been largely modified; but that modification has tended rather to its extinction than to its development upon the lines upon which it was proceeding at the time the arrestment took place. Ascertain the point of arrestment, which may in general be expected to coincide with the appearance on the scene of a race of people to whom the belief or custom or tradition is strange or unknown, and you may reasonably attribute it to the pre-existing people whom they displaced or subdued. When, therefore, savage or rude customs are stated to have existed in Rome or Greece, or the German or Celtic countries of modern Europe, it is not to be assumed, as it has hitherto been, that they are of Roman, Greek, German, or Celtic origin; but it is to be ascertained whether they embody an idea the development of which was arrested by those civilizations, and if so, they must be referred to an antecedent race of relative uncivilization. Mr. Gomme adduces in support of this conclusion the annual ceremonies connected with the worship of the village goddess in southern India. On this sole occasion in the year it is the outcast pariah, the descendant of the aboriginal race, who is the officiating priest. The goddess is generally adored in the form of an unshapen stone. Bloody ani-

mal sacrifices are offered, and the heads of the slaughtered creatures are eagerly scrambled for. Women walk naked to the temple in fulfillment of vows, under the shelter of leaves and boughs of trees. If, Mr. Gomme argues, there is a strong line of parallel between these Indian ceremonies, which are demonstrably non-Aryan, and ceremonies formerly and even still observed in Europe, must not such ceremonies have been in their origin non-Aryan in Europe?

Buddhistic Carved Figures.—At a recent meeting of the English Anthropological Institute, Major R. C. Temple illustrated a paper on the Developments of Buddhist Symbolism and Architecture as revealed in Cave Explorations, by exhibiting photographs of life-size figures in wood carved by an artist of Maulmain, of the "four sights" shown to Buddha as Prince Siddhartha on his first visits to the outer world—viz., the old man, the sick man, the dead man, and the priest; and some wooden representations from Rangoon, of Buddha in his standing and recumbent postures, with his begging bowl, and seated as King Jambopati, surrounded by priests and other worshipers. He next showed a set of gilt wooden images from the platform of the great Shnedagon pagoda at Rangoon, of various spirits believed in by the Burmese, seated on the steps of a lofty post, on the top of which is always perched the figure of the sacred goose, which apparently protects pagodas in some way. Some large glazed bricks or tiles from Pegu, at least five hundred years old, which formed the ornamentation of the procession paths round a ruined pagoda, represent the march, battle, and flight of a foreign army, depicted with elephants', monkeys', and other animal faces, with some of the figures clad in the Siamese or Cambodian fashion. A huge figure of a recumbent Buddha, of the fifteenth century, is a hundred and eighty-one feet long and forty-six feet high at the shoulder. Its history is lost, and so was the image itself, till it was accidentally discovered in the jungle by a railway contractor in 1881. Views of the Kawgun Cave were shown, exhibiting the wonderful extent of its decoration by a vast number of terra cotta tablets and images in wood, alabaster, and stone, and the extraordinary variety and multitude of objects of Buddhistic worship found in it. This cave is the richest of those which Major Temple visited; but he had examined half a dozen others in the district, and had gathered information of the existence of about forty. Many of these are hardly inferior to Kawgun in richness of Buddhistic remains, and several are said to contain besides ancient manuscripts which must now be of inestimable value. A few such manuscripts have been found.

NOTES.

WHITE bread and fine flour are named by Sir James Crichton Browne as one of the causes of the increase of dental caries. Failing to eat as large proportions of bran as our ancestors did, we are deprived to a large degree of the fluorine which they contain. The enamel of the teeth has more fluorine, in the form of fluoride of calcium, than any other part of the body. Fluorine might, indeed, be regarded as the characteristic chemical constituent of this structure, the hardest of all animal tissue; hence a supply of fluorine, while the development of the teeth is proceeding, is essential to the proper formation of the enamel, and any deficiency in this respect must result in thin and inferior enamel.

ON the reopening of an old mine at Bangor, Cal., a few months ago, flies were found in a dry slope connecting two shafts, all white except the eyes, which were red, and a white rattlesnake was killed. The animals had lived in the dry passages, where they had been supplied with air but not with light. A few of the flies, exposed to light in a glass case, recovered their proper color within a week.

A LARGE dirigible balloon, intended to make headway against air currents of twenty-eight miles an hour, is being made in France. It will be similar in form to the La France of 1884–'85, but larger—two hundred and thirty feet in length and forty-three feet in its greatest diameter. It will weigh sixty-six pounds per horse power, and will be propelled by a screw in front with a rudder behind.

FROM various experiments respecting a connection between thunderstorms and the souring of milk, Prof. H. W. Conn draws the conclusion that electricity is not of itself capable of souring milk or even of materially hastening the process; nor can the ozone developed during the thunderstorm be looked upon as of any great importance. It seems probable that the connection between the thunderstorm and the souring of milk is one of a different character. Bacteria grow most rapidly in the warm, sultry conditions which usually precede a thunder-

storm, and it will frequently happen that the thunderstorm and the souring occur together, not because the thunder has hastened the souring, but rather because the climatic conditions which have brought the storm have at the same time been such as to cause unusually rapid bacteria growth.

A VIVID sketch was given by Prof. Gruber, of Roumania, in the International Congress of Experimental Psychology, of remarkable associations of color and sound which he had been observing for many years. To a small number among his best-educated patients the sound of the vowel *e* was accompanied by a sensation of yellow color, of *i* by blue, of *o* by black, and so on through all the Roumanian vowels and diphthongs, and to some extent with numbers. The same color was not always induced by the same sound in different persons, but the observations had been carefully tested.

THE Superintendent of the Natal Observatory, in his report for 1890–'91, acknowledged his obligations to seven ladies, without whose zealous assistance, he says, the greater part of the astronomical computations, etc., would not have been carried out.

THE programme of the sanitary exhibit to be held in connection with the Chicago Exhibition defines its purpose to be to show as adequately as possible the position in which the theory and practice of hygiene stand at the present day. The programme itself is a full one, and includes classes of physical exercise, alimentation, hygiene of dwellings, hotels, lodging-houses, etc., public baths and lavatories, and numerous other features entering into the detail of hygienic management.—In connection with this subject we notice a paper on Typhoid Fever in Chicago, by William T. Sedgwick and Allen Hazen, in which the disease is shown to have increased in the city at a fearful rate within recent years. The cause of the increase is attributed to polluted water supply, which efforts are now being made to remedy.

A NEW coating for the protection of metalwork and woodwork from the effects of the weather or of water is based on the adaptability of cotton-seed oil to unite with lead. Melted lead is poured into cotton-seed oil under continual stirring, and the mixture is allowed to cool. When the oil is poured off the lead will be found at the bottom, but reduced in weight by the absorption of a part of it in the oil. The operation is repeated, with the lead left at the end of each trial, five times. When cold, the oil has the appearance of thick varnish, and is ready to be applied with a brush or a sponge. This coating unites quickly and firmly with any material.

THE price of platinum recently rose, under a speculative combination, nearly to that of gold. This stimulated the discovery of new sources of supply, and the price of the metal went down again. There are now forty mines along the course of a single river in the Ural. The grains of ore are obtained from the sand by washing. The metal as found is usually associated with gold, iron, osmium, iridium, and other rare metals, and has to be purified from them.

IT is related by the British consul at Cadiz, Spain, in illustration of the perfection with which natural wine can be imitated by modern chemical methods, that he and a friend, visiting one of the native sherry cellars there, were given two samples of wine to drink which seemed to be almost identical; and were told that one was a natural product and very costly ($250 a bottle), while the other was a manufactured product, the market price of which was only a few cents a bottle. In making the imitation, the natural product is first analyzed, and the chemist, ascertaining the exact nature of its constituent parts, is able to combine them and thus nearly reproduce the original compound.

THE longest balloon ride on record is described by M. Maurice Mallet, in L'Aéronaute. It was from La Villette, Paris, to Wahlen, in central Germany, and occupied thirty-six hours and ten minutes, from October 23 to the morning of October 25, 1892. The flight was disturbed by snow in the upper regions of the atmosphere, which melted in the lower. During one of its descents the balloon, as is characteristic of the border land, was stopped and examined by a Prussian guard, who had galloped after it for a considerable distance.

THE celebration of the three hundredth anniversary of the beginning of Galileo's labors as professor in the University of Padua, December 6, 1892, was attended by the Americans, Prof. William James, of Harvard, and Prof. Allan Marquand, of Princeton. The commemorative oration was by Prof. Antonio Favaro, who has been for fifteen years a student of Galileo, and is editor of the national edition of his works. He spoke chiefly of Galileo at Padua. He was followed by about a dozen of the foreign delegates and some of the Italian delegates. University honors were conferred upon seven foreign scientific men, representative of their several nations, including Prof. Newcomb. Besides some memorial works published by the ancient Academy of Padua, and by the university, the students of the university are about to issue a collection of documents relating to the sojourn of the philosopher at Padua.

HERR NAGEL has succeeded in localizing the sense of taste of sea anemones in their tentacles. A piece of sardine brought carefully to the tentacles of one of these animals was seized at once by the one touched, then by the others, and was swallowed. A piece

of blotting paper saturated with sea-water and applied in the same way was not seized; when soaked in the juice of fish, it was seized with the same energy as the piece of fish, but was often given up ultimately without being swallowed; soaked with sugar, it was accepted more daintily; but if saturated with quinine it was refused, the tentacles drawing back. On the outer surface of the body, and on the part between the tentacles and the mouth, quinine had no effect; nor did several other drugs of similar properties. Meat placed within or near the mouth of a widely open animal was not noticed; it was seized only when the tentacles were touched.

AMONG some recently observed interesting results of application of cold, M. Raoul Pictet has found that at −150° all chemical reaction is suppressed. Thus, if sulphuric acid and potash are brought together at this temperature, they do not combine. Litmus paper, introduced, keeps its color. It is possible to restore energy to these substances by passing the electric current, and the current passes readily, whatever the substances; at −150° all bodies are good conductors. The disappearance of affinity at a low temperature can be utilized to get absolutely pure substances; and M. Pictet has thus obtained alcohol, chloroform, ether, and glycerin.

A LAW has been enacted in Ontario forbidding the spraying or sprinkling of fruit trees while they are in bloom with any mixture containing Paris green or other substances poisonous or injurious to bees. The object of the legislation is to protect the bees from harm, the honey from possible taint of poisoning, and to avoid possible obstacles to the complete fertilization of the fruit.

THE Prussian Government has decided to introduce the use of the centigrade thermometer instead of that of Réaumur, which was still in use in some parts of the kingdom.

FROM a careful review of the characteristics as to inheritability of certain diseased conditions of the human system, Henry J. Tilden has drawn the conclusion that pathology, so far from offering any support to the hypothesis of the transmission of acquired characters, pronounces against it.

AMONG the congresses to be held at Chicago by the World's Congress Auxiliary of the Columbian Exposition will be an international conference on aërial navigation. Its objects will be to bring about the discussion of some of the scientific problems involved, to collate the results of the latest researches, to procure an interchange of ideas, and to promote concert of action among the students of this inchoate subject. The meetings will be held on the afternoons of August 1st, 2d, and 3d. The topics to be discussed will be arranged under the three headings of Scientific Principles, Aviation, and Ballooning.

OBITUARY NOTES.

THE death is announced of John Obadiah Westwood, President of the British Entomological Society. He was born in 1805, at Sheffield, and was appointed a Professor of Zoölogy at Oxford in 1861. He received a royal medal from the Royal Society for his scientific work in 1855, and was elected a member of the Entomological Society in Paris, to succeed Humboldt, in 1860. He was author of an introduction to the Modern Classification of Insects, British Butterflies and their Transformations, and other works of a similar nature.

F. VON HELLWALD, a well-known Austrian writer on ethnography, died in Bavaria, November 1, 1892, in the fiftieth year of his age. He entered the army, but left it in 1864 to engage in scientific studies, then reentered it and took part in the Austro-Prussian War. He was for several years editor of *Das Ausland*. Since 1882 he had devoted himself chiefly to the production of works relating to geography and the history of civilization.

JAMES PLANT, of Leicester, a distinguished English local geologist, died in November, 1892, in the seventy-fifth year of his age. He was chairman of the British Association's Committee on Erratic Blocks.

PROF. E. N. HORSFORD, of Harvard University, died in Cambridge, Mass., January 1st. After four years of service as teacher of mathematics and natural sciences in Albany Female Academy, he spent two years of study and research in the Liebig Laboratory at Giessen. Returning home, he became Rumford Professor of Science applied to the Arts. He afterward submitted plans which led to the foundation of the Lawrence Scientific School, where he spent nineteen years. He then went into business in the manufacture of chemicals, and became President of the Rumford Chemical Works. He published a paper more than thirty years ago on stilling the waves with oil. He was interested in archæology; published a lexicon of five Indian languages; and tried to determine the location of the ancient settlement of Norumbega on Charles River, Mass.

AMEDÉE GUILLEMIN, one of the most successful and eminent French popularizers of science, died early in January, at his native village of Pierre, France. He was born in 1826, and began the publication of his celebrated works in physics and astronomy in 1864, with *La Ciel* (the sky). This was followed by similar works on comets, etc., The Physical World, the *Petit encyclopédie populaire*, in sixteen volumes, the books on Steam and Railroads in the Library of Wonders, etc. He was a frequent contributor to La Nature.